

Kristin Adachi
CS431
2/27/17

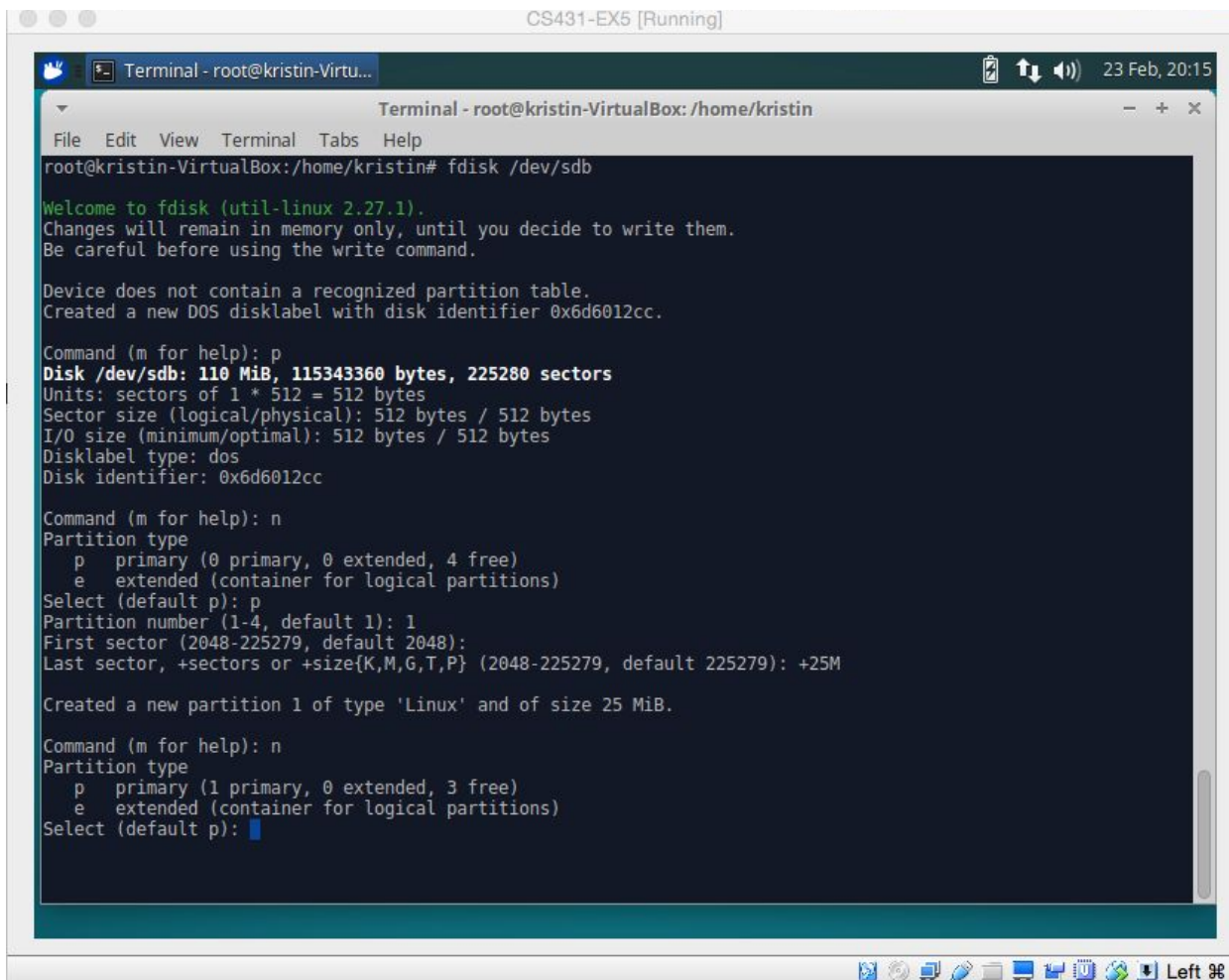
Exercise 5

Adding a Disk:

After setting up the virtual machine, I added a disk of size 110MB.

Creating Partitions:

The `fdisk` command was used to create four partitions of size 25MB each on the disk I created.



```
CS431-EX5 [Running]
Terminal - root@kristin-Virtu...
Terminal - root@kristin-VirtualBox: /home/kristin
File Edit View Terminal Tabs Help
root@kristin-VirtualBox:/home/kristin# fdisk /dev/sdb

Welcome to fdisk (util-linux 2.27.1).
Changes will remain in memory only, until you decide to write them.
Be careful before using the write command.

Device does not contain a recognized partition table.
Created a new DOS disklabel with disk identifier 0x6d6012cc.

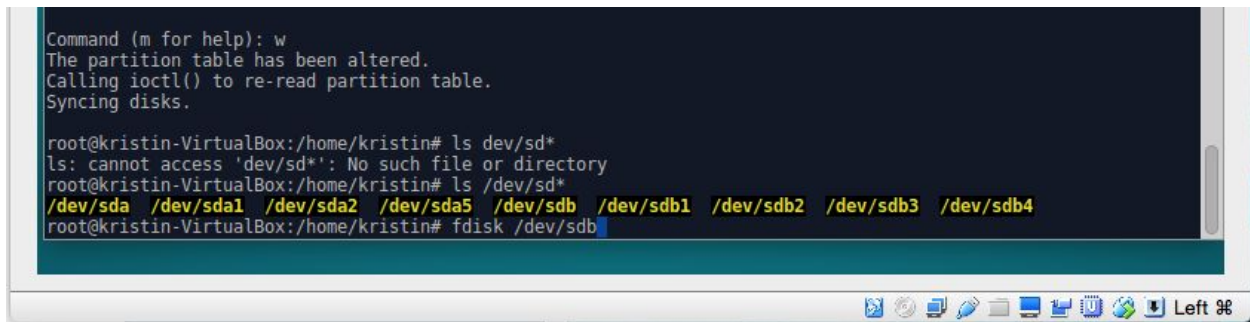
Command (m for help): p
Disk /dev/sdb: 110 MiB, 115343360 bytes, 225280 sectors
Units: sectors of 1 * 512 = 512 bytes
Sector size (logical/physical): 512 bytes / 512 bytes
I/O size (minimum/optimal): 512 bytes / 512 bytes
Disklabel type: dos
Disk identifier: 0x6d6012cc

Command (m for help): n
Partition type
  p   primary (0 primary, 0 extended, 4 free)
  e   extended (container for logical partitions)
Select (default p): p
Partition number (1-4, default 1): 1
First sector (2048-225279, default 2048):
Last sector, +sectors or +size{K,M,G,T,P} (2048-225279, default 225279): +25M

Created a new partition 1 of type 'Linux' and of size 25 MiB.

Command (m for help): n
Partition type
  p   primary (1 primary, 0 extended, 3 free)
  e   extended (container for logical partitions)
Select (default p):
```

After adding the 4 partitions, the table was written to the disk and the `fdisk` program was exited. After running `ls /dev/sd*` again, it produced this output:

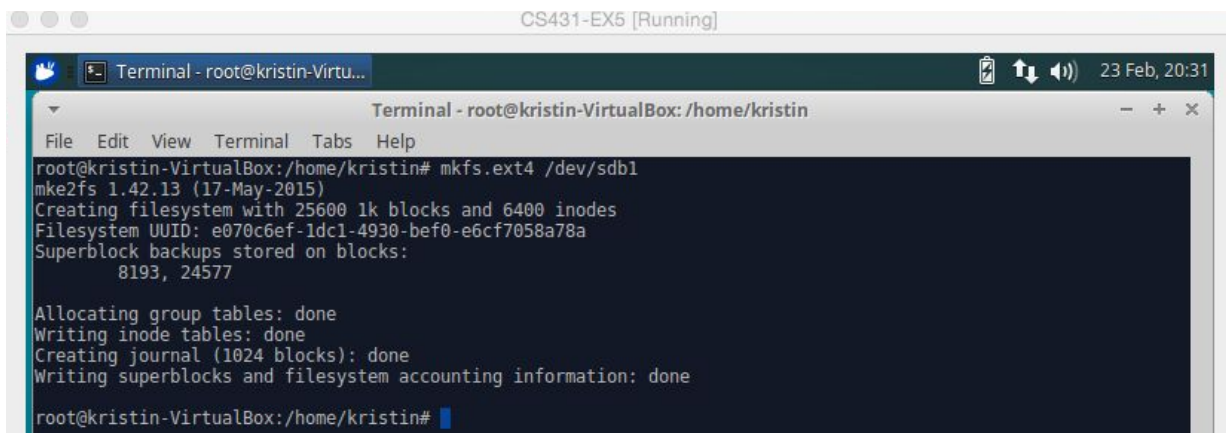


```
Command (m for help): w
The partition table has been altered.
Calling ioctl() to re-read partition table.
Syncing disks.

root@kristin-VirtualBox:/home/kristin# ls dev/sd*
ls: cannot access 'dev/sd*': No such file or directory
root@kristin-VirtualBox:/home/kristin# ls /dev/sd*
/dev/sda /dev/sda1 /dev/sda2 /dev/sda5 /dev/sdb /dev/sdb1 /dev/sdb2 /dev/sdb3 /dev/sdb4
root@kristin-VirtualBox:/home/kristin# fdisk /dev/sdb
```

Creating ext4 File System:

The `mkfs.ext4` command was used to create a new ext4 file system on `/dev/sdb1`.



```
CS431-EX5 [Running]

Terminal - root@kristin-Virtu... 23 Feb, 20:31

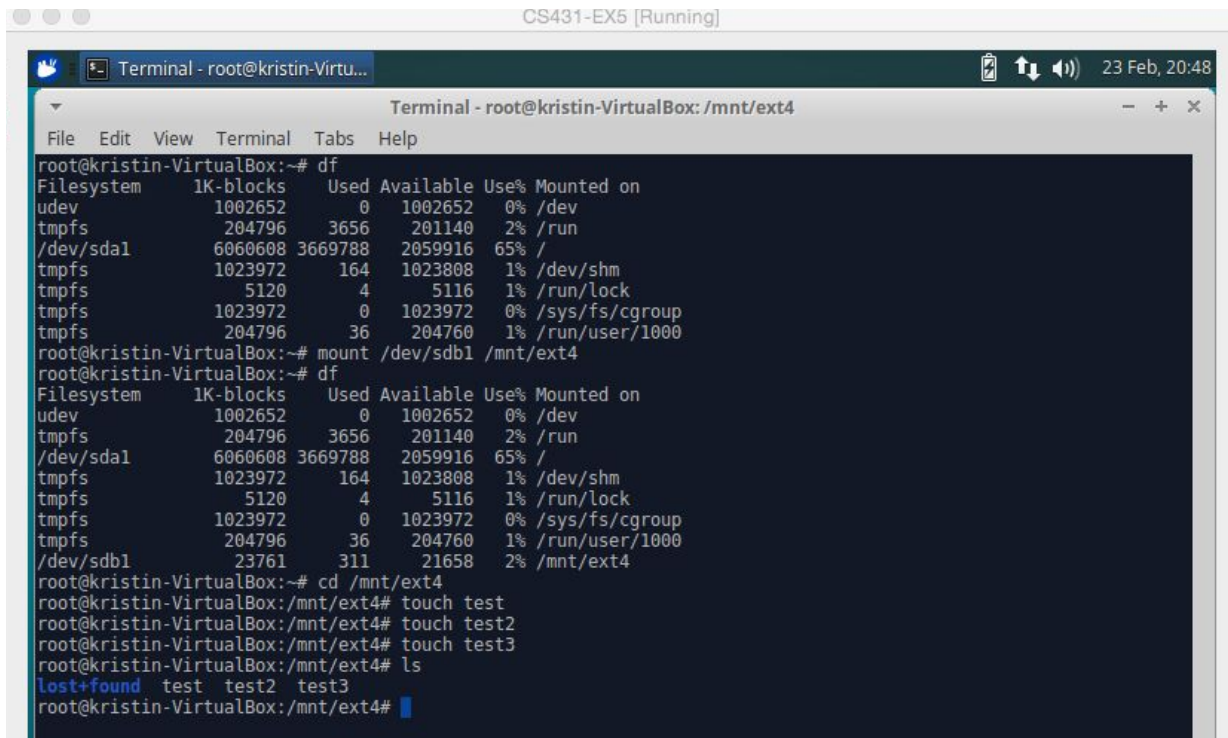
Terminal - root@kristin-VirtualBox: /home/kristin
File Edit View Terminal Tabs Help

root@kristin-VirtualBox:/home/kristin# mkfs.ext4 /dev/sdb1
mke2fs 1.42.13 (17-May-2015)
Creating filesystem with 25600 1k blocks and 6400 inodes
Filesystem UUID: e070c6ef-1dc1-4930-bef0-e6cf7058a78a
Superblock backups stored on blocks:
    8193, 24577

Allocating group tables: done
Writing inode tables: done
Creating journal (1024 blocks): done
Writing superblocks and filesystem accounting information: done

root@kristin-VirtualBox:/home/kristin#
```

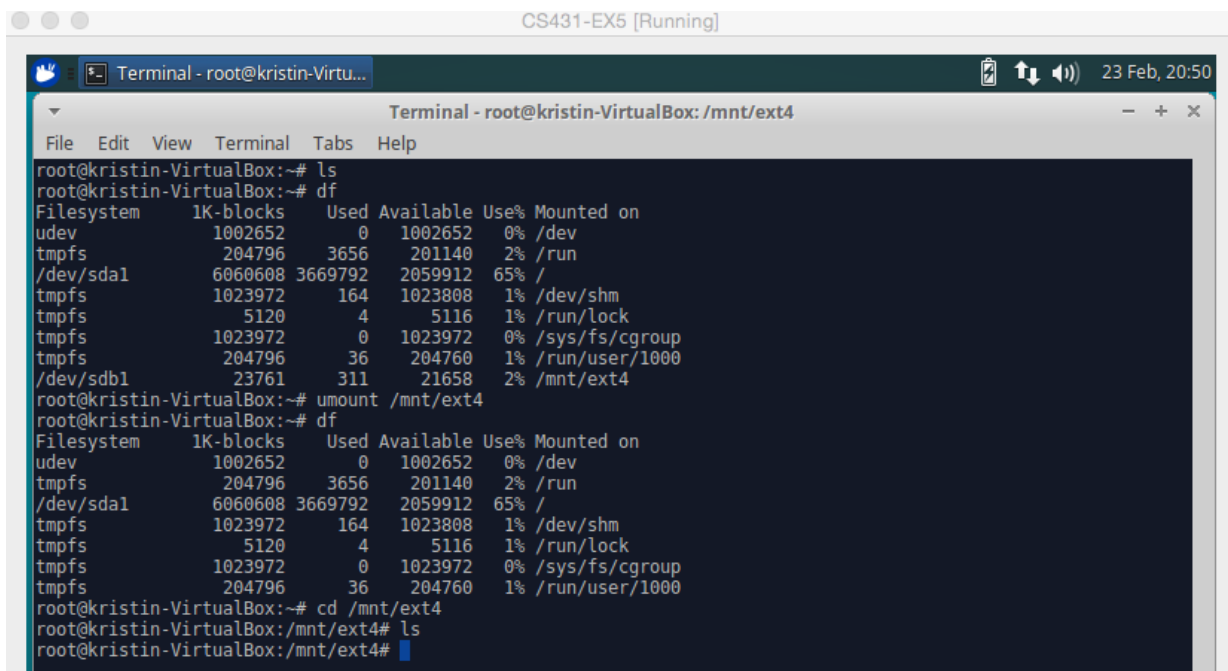
After it was created, the file system was mounted onto the OS's directory tree to be accessed. I made a directory called `/mnt/ext4` and used the `mount` command to mount the file system.



The terminal window shows the process of mounting an ext4 file system. It starts with a `df` command showing disk usage. Then, the `mount /dev/sdb1 /mnt/ext4` command is executed. Another `df` command shows the new mount point. The user then changes to the `/mnt/ext4` directory and creates three files: `test`, `test2`, and `test3`. Finally, an `ls` command shows the files, with `lost+found` appearing at the beginning of the list.

```
root@kristin-VirtualBox:~# df
Filesystem      1K-blocks    Used Available Use% Mounted on
udev            1002652         0   1002652   0% /dev
tmpfs           204796       3656    201140   2% /run
/dev/sda1       6060608 3669788  2059916  65% /
tmpfs           1023972       164   1023808   1% /dev/shm
tmpfs           5120          4     5116    1% /run/lock
tmpfs           1023972         0   1023972   0% /sys/fs/cgroup
tmpfs           204796        36    204760   1% /run/user/1000
root@kristin-VirtualBox:~# mount /dev/sdb1 /mnt/ext4
root@kristin-VirtualBox:~# df
Filesystem      1K-blocks    Used Available Use% Mounted on
udev            1002652         0   1002652   0% /dev
tmpfs           204796       3656    201140   2% /run
/dev/sda1       6060608 3669788  2059916  65% /
tmpfs           1023972       164   1023808   1% /dev/shm
tmpfs           5120          4     5116    1% /run/lock
tmpfs           1023972         0   1023972   0% /sys/fs/cgroup
tmpfs           204796        36    204760   1% /run/user/1000
/dev/sdb1       23761        311    21658    2% /mnt/ext4
root@kristin-VirtualBox:~# cd /mnt/ext4
root@kristin-VirtualBox:/mnt/ext4# touch test
root@kristin-VirtualBox:/mnt/ext4# touch test2
root@kristin-VirtualBox:/mnt/ext4# touch test3
root@kristin-VirtualBox:/mnt/ext4# ls
lost+found test test2 test3
root@kristin-VirtualBox:/mnt/ext4#
```

After mounting, I changed directory into the new file system and created files `test`, `test2`, and `test3`. Then, I dismounted the file system using the `umount` command.

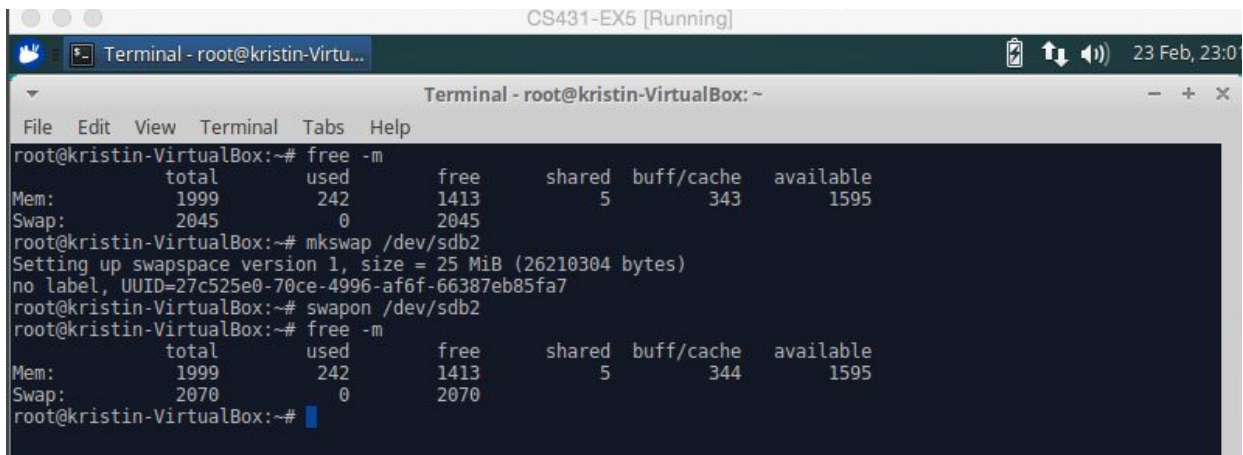


The terminal window shows the process of unmounting the ext4 file system. It starts with an `ls` command in the root directory. Then, the `df` command is run. The `umount /mnt/ext4` command is executed. Another `df` command shows that the mount point is no longer present. The user then changes to the `/mnt/ext4` directory and runs an `ls` command, which shows an empty directory.

```
root@kristin-VirtualBox:~# ls
root@kristin-VirtualBox:~# df
Filesystem      1K-blocks    Used Available Use% Mounted on
udev            1002652         0   1002652   0% /dev
tmpfs           204796       3656    201140   2% /run
/dev/sda1       6060608 3669792  2059912  65% /
tmpfs           1023972       164   1023808   1% /dev/shm
tmpfs           5120          4     5116    1% /run/lock
tmpfs           1023972         0   1023972   0% /sys/fs/cgroup
tmpfs           204796        36    204760   1% /run/user/1000
/dev/sdb1       23761        311    21658    2% /mnt/ext4
root@kristin-VirtualBox:~# umount /mnt/ext4
root@kristin-VirtualBox:~# df
Filesystem      1K-blocks    Used Available Use% Mounted on
udev            1002652         0   1002652   0% /dev
tmpfs           204796       3656    201140   2% /run
/dev/sda1       6060608 3669792  2059912  65% /
tmpfs           1023972       164   1023808   1% /dev/shm
tmpfs           5120          4     5116    1% /run/lock
tmpfs           1023972         0   1023972   0% /sys/fs/cgroup
tmpfs           204796        36    204760   1% /run/user/1000
root@kristin-VirtualBox:~# cd /mnt/ext4
root@kristin-VirtualBox:/mnt/ext4# ls
root@kristin-VirtualBox:/mnt/ext4#
```

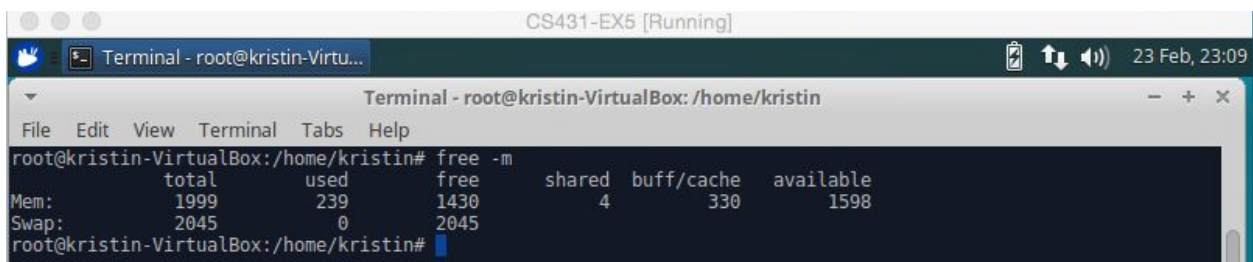
Creating Swap Space:

A swap space was created by running using the `mkswap` command and enabled by using the `swapon` command. I ran `free -m` before and after to show the change in free memory.



```
CS431-EX5 [Running]
Terminal - root@kristin-Virtu...
Terminal - root@kristin-VirtualBox: ~
File Edit View Terminal Tabs Help
root@kristin-VirtualBox:~# free -m
              total        used        free      shared  buff/cache   available
Mem:           1999          242         1413           5         343         1595
Swap:           2045           0          2045
root@kristin-VirtualBox:~# mkswap /dev/sdb2
Setting up swspace version 1, size = 25 MiB (26210304 bytes)
no label, UUID=27c525e0-70ce-4996-af6f-66387eb85fa7
root@kristin-VirtualBox:~# swapon /dev/sdb2
root@kristin-VirtualBox:~# free -m
              total        used        free      shared  buff/cache   available
Mem:           1999          242         1413           5         344         1595
Swap:           2070           0          2070
root@kristin-VirtualBox:~#
```

After restarting and running `free -m` again, the swap space is gone.

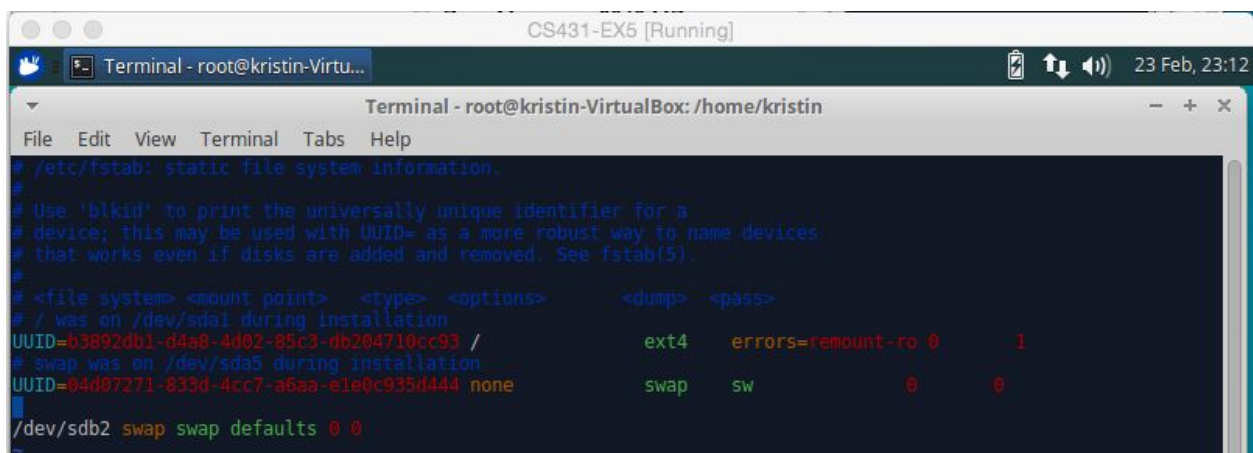


```
CS431-EX5 [Running]
Terminal - root@kristin-Virtu...
Terminal - root@kristin-VirtualBox: /home/kristin
File Edit View Terminal Tabs Help
root@kristin-VirtualBox:/home/kristin# free -m
              total        used        free      shared  buff/cache   available
Mem:           1999          239         1430           4          330         1598
Swap:           2045           0          2045
root@kristin-VirtualBox:/home/kristin#
```

To fix this issue, I added a line to the bottom of the file system table file (`/etc/fstab`):

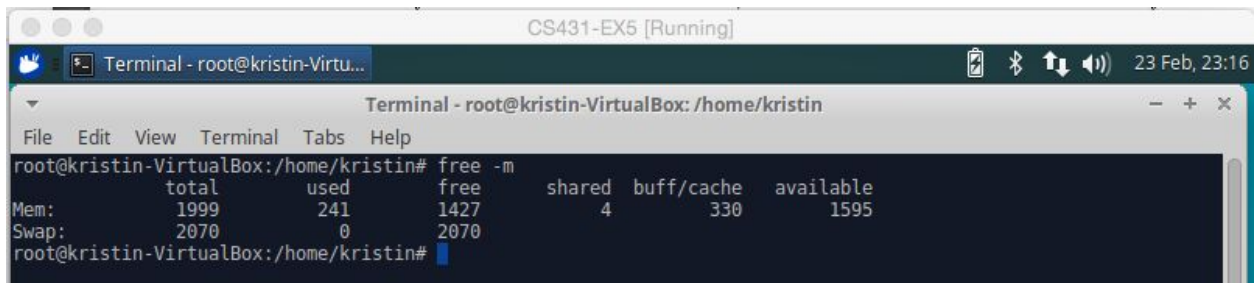
```
/dev/sdb2 swap swap defaults 0 0
```

This refers to the file system, mount point, type, options, dump, and pass respectively.



```
CS431-EX5 [Running]
Terminal - root@kristin-Virtu...
Terminal - root@kristin-VirtualBox: /home/kristin
File Edit View Terminal Tabs Help
# /etc/fstab: static file system information.
#
# Use 'blkid' to print the universally unique identifier for a
# device; this may be used with UUID= as a more robust way to name devices
# that works even if disks are added and removed. See fstab(5).
#
# <file system> <mount point> <type> <options>      <dump> <pass>
# / was on /dev/sda1 during installation
UUID=b3892db1-d4a8-4d02-85c3-db204710cc93 /          ext4      errors=remount-ro 0      1
# swap was on /dev/sda5 during installation
UUID=04d07271-833d-4cc7-a6aa-e1e0c935d444 none        swap      sw          0      0
/dev/sdb2 swap swap defaults 0 0
```


After rebooting and running `free -m` again, I noticed that the swap space remained after the line was added to the file system table file.

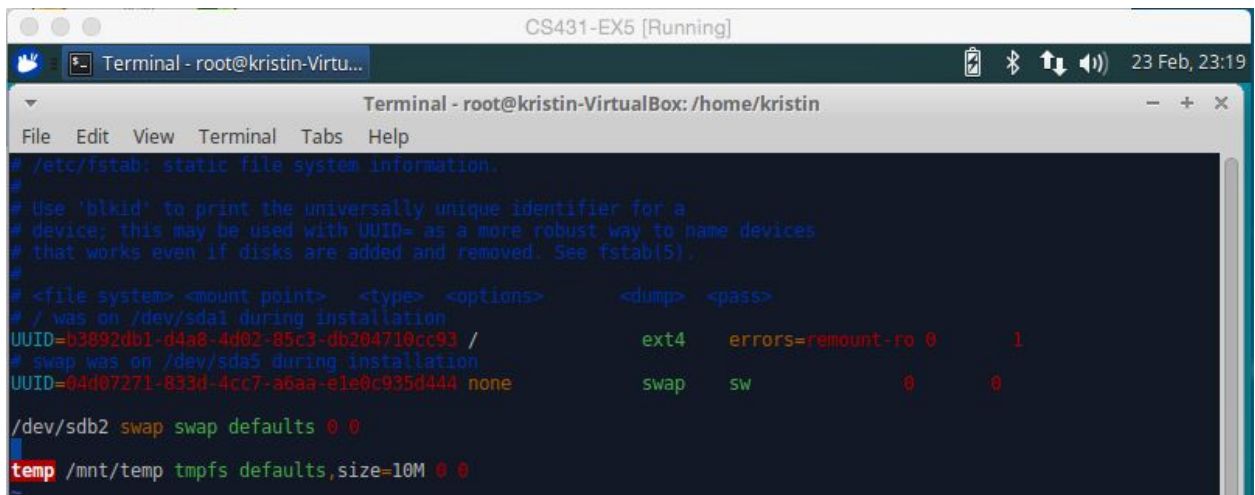


```
CS431-EX5 [Running]
Terminal - root@kristin-Virtu...
Terminal - root@kristin-VirtualBox: /home/kristin
File Edit View Terminal Tabs Help
root@kristin-VirtualBox:/home/kristin# free -m
              total        used        free      shared  buff/cache   available
Mem:           1999          241         1427           4          330         1595
Swap:          2070           0          2070
```

I used `fstab` to create a RAM disk by adding an additional line to the file system table file:

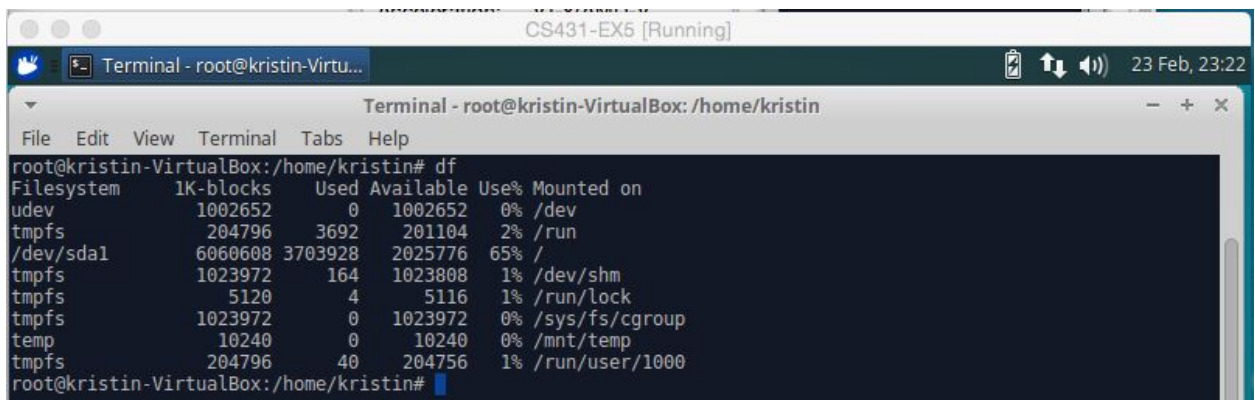
```
temp /mnt/temp tmpfs defaults,size=10M 0 0
```

This creates a RAM disk of size 10MB and mounts at `/mnt/temp` when the system is rebooted.



```
CS431-EX5 [Running]
Terminal - root@kristin-Virtu...
Terminal - root@kristin-VirtualBox: /home/kristin
File Edit View Terminal Tabs Help
# /etc/fstab: static file system information.
#
# Use 'blkid' to print the universally unique identifier for a
# device; this may be used with UUID= as a more robust way to name devices
# that works even if disks are added and removed. See fstab(5).
#
# <file system> <mount point> <type> <options>      <dump> <pass>
# / was on /dev/sda1 during installation
UUID=b3892db1-d4a8-4d02-85c3-db204710cc93 /          ext4    errors=remount-ro 0      1
# swap was on /dev/sda5 during installation
UUID=04d07271-833d-4cc7-a6aa-e1e0c935d444 none        swap    sw              0      0
/dev/sdb2 swap swap defaults 0 0
temp /mnt/temp tmpfs defaults,size=10M 0 0
```

After rebooting, the RAM disk is created and automatically mounted:



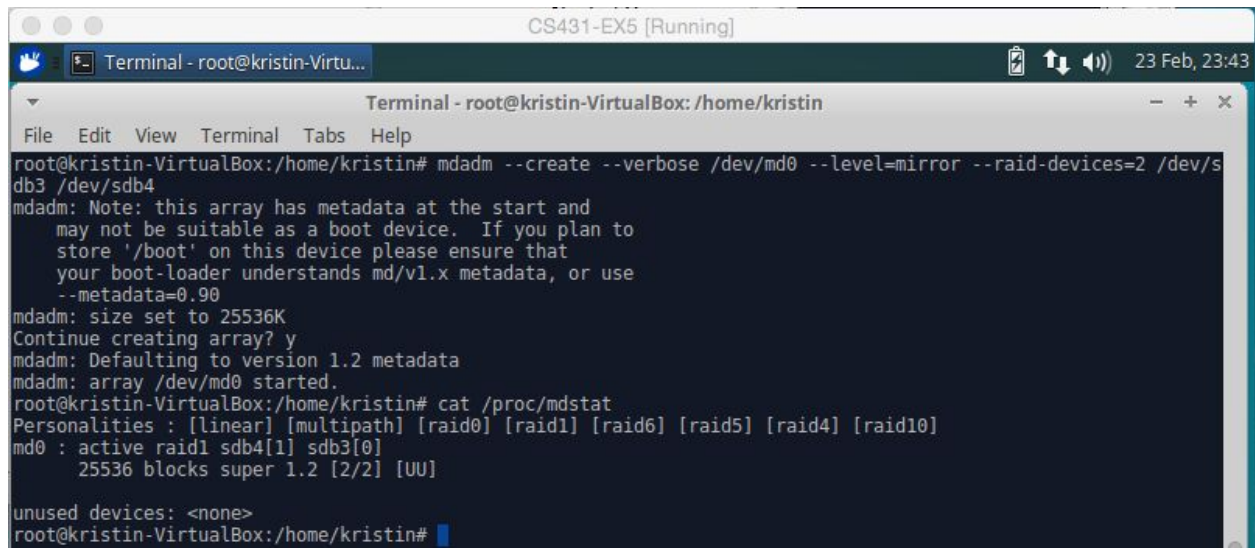
```
CS431-EX5 [Running]
Terminal - root@kristin-Virtu...
Terminal - root@kristin-VirtualBox: /home/kristin
File Edit View Terminal Tabs Help
root@kristin-VirtualBox:/home/kristin# df
Filesystem      1K-blocks    Used Available Use% Mounted on
udev             1002652      0    1002652   0% /dev
tmpfs            204796      3692    201104    2% /run
/dev/sda1        6060608 3703928  2025776  65% /
tmpfs            1023972      164    1023808   1% /dev/shm
tmpfs             5120         4       5116   1% /run/lock
tmpfs            1023972      0    1023972   0% /sys/fs/cgroup
tmpfs            10240       0     10240   0% /mnt/temp
tmpfs            204796      40     204756   1% /run/user/1000
root@kristin-VirtualBox:/home/kristin#
```

Creating a RAID1 Mirror:

I used the mdadm to create a RAID1 mirror. After successfully creating it, I ran the command:

```
cat /proc/mdstat
```

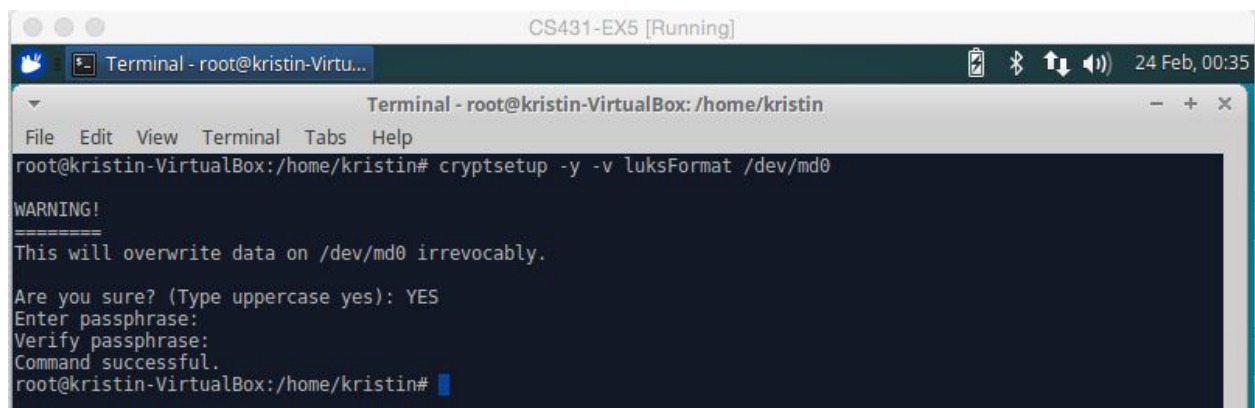
This outputted the following:

A terminal window titled "Terminal - root@kristin-Virtu..." with a menu bar (File, Edit, View, Terminal, Tabs, Help). The terminal shows the command "mdadm --create --verbose /dev/md0 --level=mirror --raid-devices=2 /dev/sdb3 /dev/sdb4" and its output. The output includes a note about metadata, the size set to 25536K, confirmation to continue, defaulting to version 1.2 metadata, and the array starting. It then shows the output of "cat /proc/mdstat" which lists personalities and shows md0 as an active raid1 with 25536 blocks. Finally, it shows "unused devices: <none>".

```
root@kristin-VirtualBox:/home/kristin# mdadm --create --verbose /dev/md0 --level=mirror --raid-devices=2 /dev/sdb3 /dev/sdb4
mdadm: Note: this array has metadata at the start and
may not be suitable as a boot device. If you plan to
store '/boot' on this device please ensure that
your boot-loader understands md/v1.x metadata, or use
--metadata=0.90
mdadm: size set to 25536K
Continue creating array? y
mdadm: Defaulting to version 1.2 metadata
mdadm: array /dev/md0 started.
root@kristin-VirtualBox:/home/kristin# cat /proc/mdstat
Personalities : [linear] [multipath] [raid0] [raid1] [raid6] [raid5] [raid4] [raid10]
md0 : active raid1 sdb4[1] sdb3[0]
      25536 blocks super 1.2 [2/2] [UU]

unused devices: <none>
root@kristin-VirtualBox:/home/kristin#
```

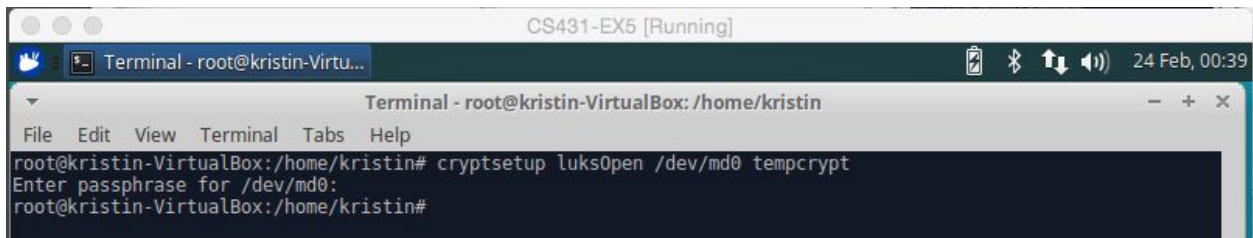
I used the LUKS (Linux Unified Key Setup) to create an encrypted file system on top of this RAID1 device. An encrypted file system was created on /dev/md0 by using `cryptsetup luksFormat`.

A terminal window titled "Terminal - root@kristin-Virtu..." with a menu bar (File, Edit, View, Terminal, Tabs, Help). The terminal shows the command "cryptsetup -y -v luksFormat /dev/md0" and its output. The output includes a warning about overwriting data, a confirmation to proceed, and the successful completion of the command.

```
root@kristin-VirtualBox:/home/kristin# cryptsetup -y -v luksFormat /dev/md0
WARNING!
=====
This will overwrite data on /dev/md0 irrevocably.

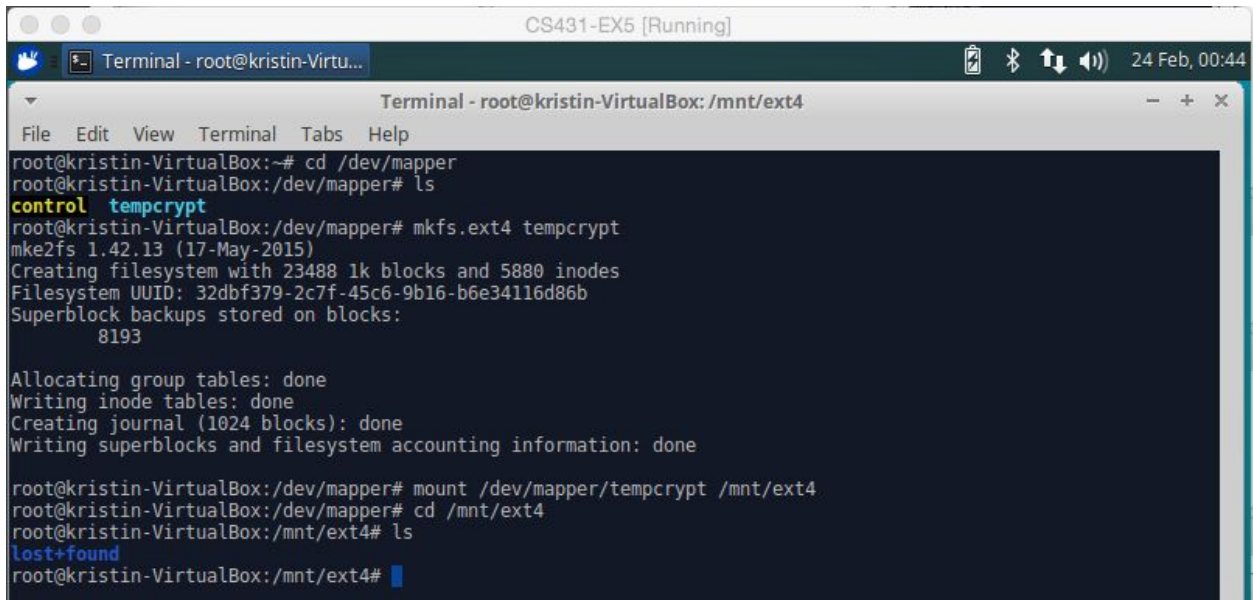
Are you sure? (Type uppercase yes): YES
Enter passphrase:
Verify passphrase:
Command successful.
root@kristin-VirtualBox:/home/kristin#
```

Then, `cryptsetup luksOpen` was used to open the encrypted file system and put a reference to it in `/dev/mapper`. I chose to open it as `tempcrypt`.

A terminal window titled "Terminal - root@kristin-Virtu..." is shown. The prompt is root@kristin-VirtualBox:/home/kristin. The command cryptsetup luksOpen /dev/md0 tempcrypt is entered. The prompt changes to root@kristin-VirtualBox:/home/kristin# after the command is executed.

```
CS431-EX5 [Running]
Terminal - root@kristin-Virtu...
Terminal - root@kristin-VirtualBox: /home/kristin
File Edit View Terminal Tabs Help
root@kristin-VirtualBox:/home/kristin# cryptsetup luksOpen /dev/md0 tempcrypt
Enter passphrase for /dev/md0:
root@kristin-VirtualBox:/home/kristin#
```

I created a file system on `/dev/mapper/tempcrypt` by using `mkfs.ext4` again. After, I mounted the newly created file system using the `mount` command.

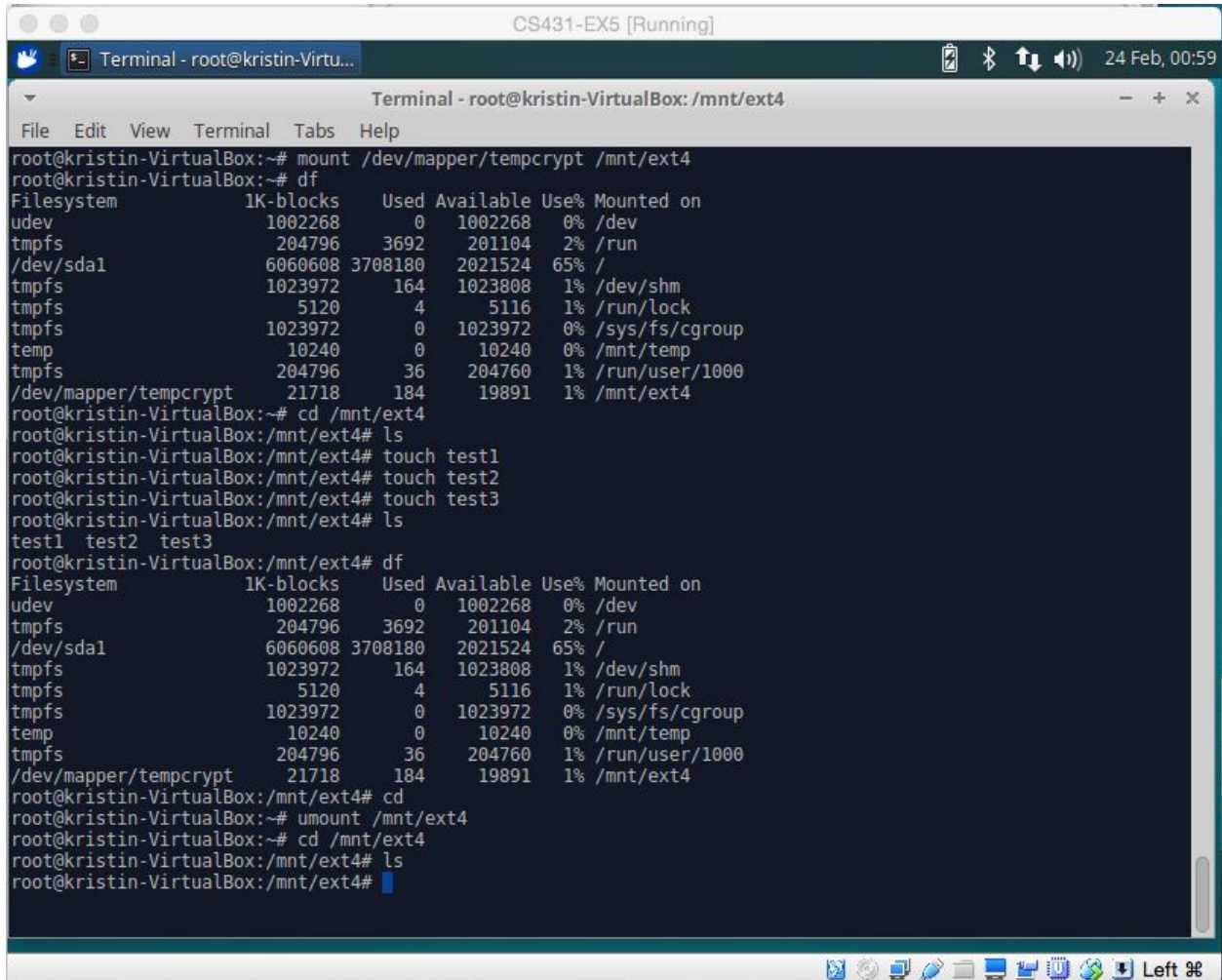
A terminal window titled "Terminal - root@kristin-Virtu..." is shown. The prompt is root@kristin-VirtualBox:~#. The user navigates to /dev/mapper and lists its contents, showing tempcrypt. Then, mkfs.ext4 tempcrypt is run, creating an ext4 filesystem. The user then mounts it to /mnt/ext4 and lists its contents, showing lost+found.

```
CS431-EX5 [Running]
Terminal - root@kristin-Virtu...
Terminal - root@kristin-VirtualBox: /mnt/ext4
File Edit View Terminal Tabs Help
root@kristin-VirtualBox:~# cd /dev/mapper
root@kristin-VirtualBox:/dev/mapper# ls
control tempcrypt
root@kristin-VirtualBox:/dev/mapper# mkfs.ext4 tempcrypt
mke2fs 1.42.13 (17-May-2015)
Creating filesystem with 23488 1k blocks and 5880 inodes
Filesystem UUID: 32dbf379-2c7f-45c6-9b16-b6e34116d86b
Superblock backups stored on blocks:
    8193

Allocating group tables: done
Writing inode tables: done
Creating journal (1024 blocks): done
Writing superblocks and filesystem accounting information: done

root@kristin-VirtualBox:/dev/mapper# mount /dev/mapper/tempcrypt /mnt/ext4
root@kristin-VirtualBox:/dev/mapper# cd /mnt/ext4
root@kristin-VirtualBox:/mnt/ext4# ls
lost+found
root@kristin-VirtualBox:/mnt/ext4#
```

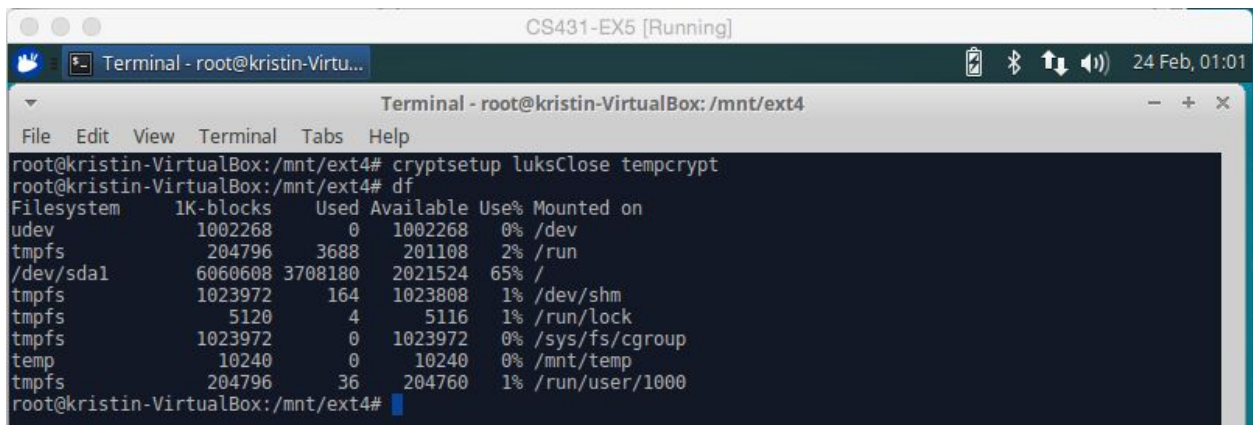
Again, I created some files test1, test2, and test3 and then dismounted the file system.



A terminal window titled "Terminal - root@kristin-Virtu..." with a menu bar (File, Edit, View, Terminal, Tabs, Help). The terminal shows the following commands and output:

```
root@kristin-VirtualBox:~# mount /dev/mapper/tempcrypt /mnt/ext4
root@kristin-VirtualBox:~# df
Filesystem            1K-blocks    Used Available Use% Mounted on
udev                  1002268        0   1002268   0% /dev
tmpfs                  204796    3692    201104   2% /run
/dev/sda1             6060608 3708180  2021524  65% /
tmpfs                  1023972    164   1023808   1% /dev/shm
tmpfs                   5120         4     5116   1% /run/lock
tmpfs                  1023972        0   1023972   0% /sys/fs/cgroup
temp                   10240         0     10240   0% /mnt/temp
tmpfs                  204796     36   204760   1% /run/user/1000
/dev/mapper/tempcrypt  21718     184   19891   1% /mnt/ext4
root@kristin-VirtualBox:~# cd /mnt/ext4
root@kristin-VirtualBox:/mnt/ext4# ls
root@kristin-VirtualBox:/mnt/ext4# touch test1
root@kristin-VirtualBox:/mnt/ext4# touch test2
root@kristin-VirtualBox:/mnt/ext4# touch test3
root@kristin-VirtualBox:/mnt/ext4# ls
test1 test2 test3
root@kristin-VirtualBox:/mnt/ext4# df
Filesystem            1K-blocks    Used Available Use% Mounted on
udev                  1002268        0   1002268   0% /dev
tmpfs                  204796    3692    201104   2% /run
/dev/sda1             6060608 3708180  2021524  65% /
tmpfs                  1023972    164   1023808   1% /dev/shm
tmpfs                   5120         4     5116   1% /run/lock
tmpfs                  1023972        0   1023972   0% /sys/fs/cgroup
temp                   10240         0     10240   0% /mnt/temp
tmpfs                  204796     36   204760   1% /run/user/1000
/dev/mapper/tempcrypt  21718     184   19891   1% /mnt/ext4
root@kristin-VirtualBox:/mnt/ext4# cd
root@kristin-VirtualBox:~# umount /mnt/ext4
root@kristin-VirtualBox:~# cd /mnt/ext4
root@kristin-VirtualBox:/mnt/ext4# ls
root@kristin-VirtualBox:/mnt/ext4#
```

Finally, I closed the encrypted file system by using `cryptsetup luksClose` .



A terminal window titled "Terminal - root@kristin-Virtu..." with a menu bar (File, Edit, View, Terminal, Tabs, Help). The terminal shows the following commands and output:

```
root@kristin-VirtualBox:/mnt/ext4# cryptsetup luksClose tempcrypt
root@kristin-VirtualBox:/mnt/ext4# df
Filesystem            1K-blocks    Used Available Use% Mounted on
udev                  1002268        0   1002268   0% /dev
tmpfs                  204796    3688    201108   2% /run
/dev/sda1             6060608 3708180  2021524  65% /
tmpfs                  1023972    164   1023808   1% /dev/shm
tmpfs                   5120         4     5116   1% /run/lock
tmpfs                  1023972        0   1023972   0% /sys/fs/cgroup
temp                   10240         0     10240   0% /mnt/temp
tmpfs                  204796     36   204760   1% /run/user/1000
root@kristin-VirtualBox:/mnt/ext4#
```