

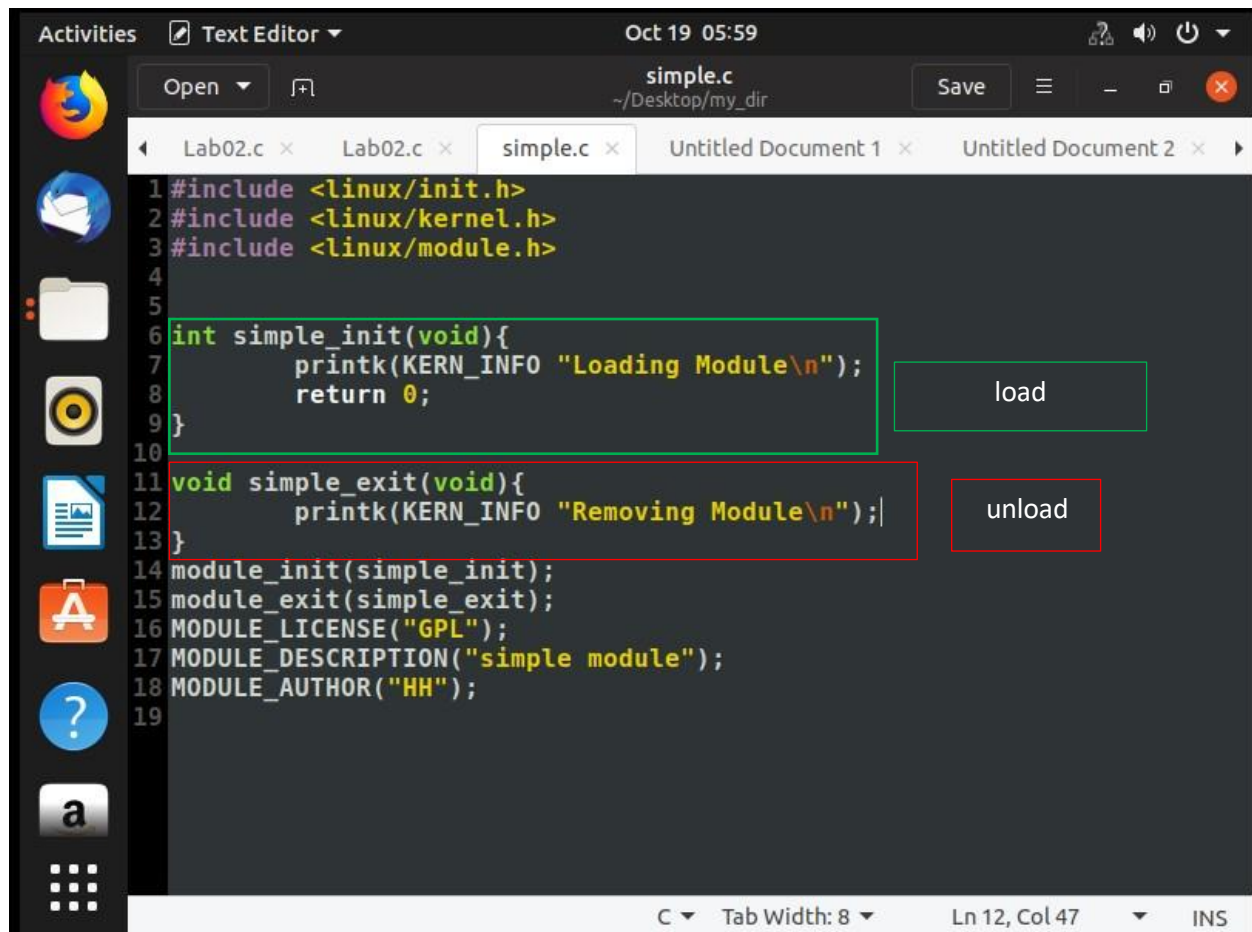
تمرین ها:

-1

توضیح:

1. ابتدا یک فایل c. به اسم simple می سازیم و سپس کد زیر که در دستورکار هم موجود است را (برای load و unload است)

می نویسیم.

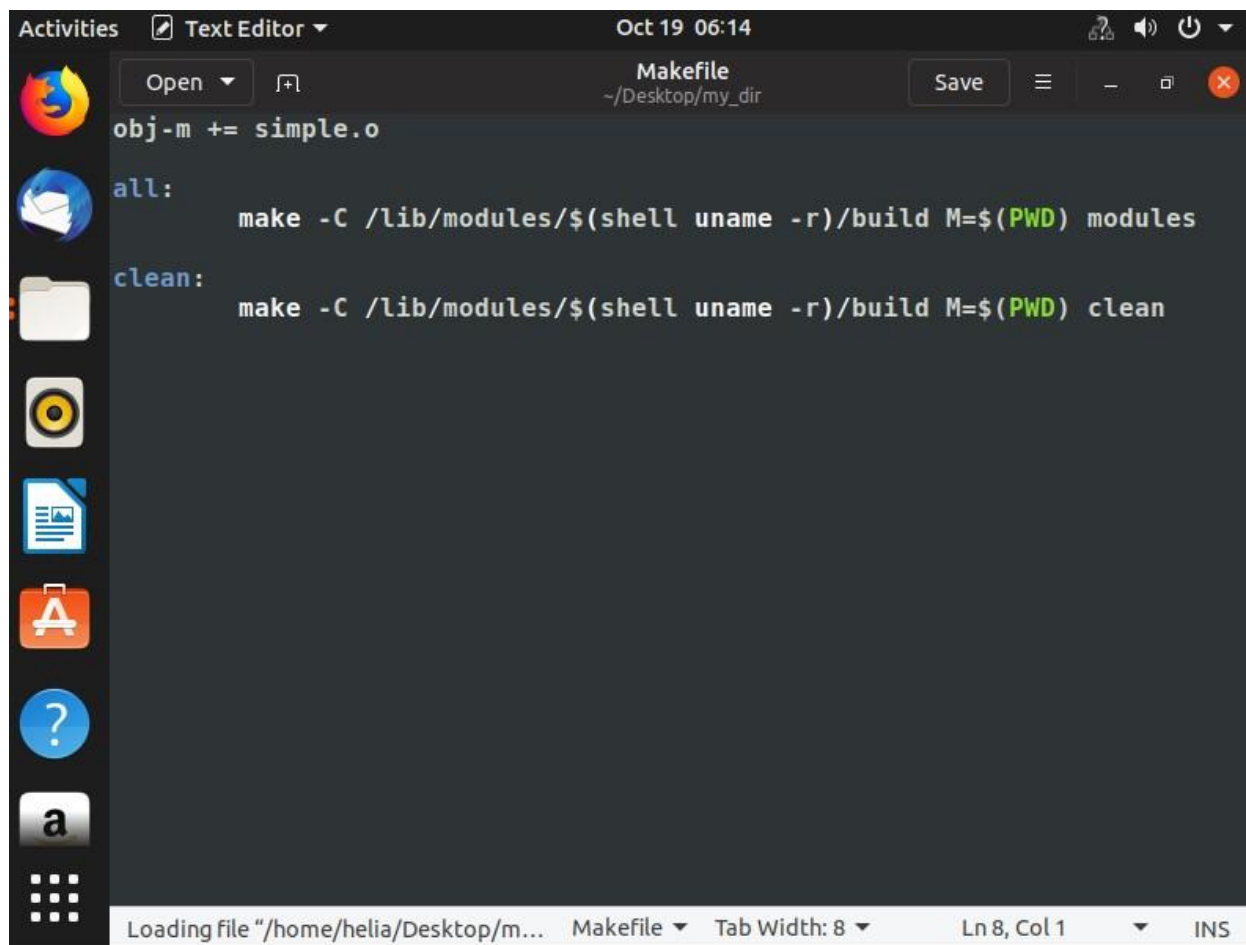


```
1#include <linux/init.h>
2#include <linux/kernel.h>
3#include <linux/module.h>
4
5
6int simple_init(void){
7    printk(KERN_INFO "Loading Module\n");
8    return 0;
9}
10
11void simple_exit(void){
12    printk(KERN_INFO "Removing Module\n");
13}
14module_init(simple_init);
15module_exit(simple_exit);
16MODULE_LICENSE("GPL");
17MODULE_DESCRIPTION("simple module");
18MODULE_AUTHOR("HH");
19
```

load

unload

2. یک فایل به اسم Makefile ساخیم و دستورات زیر را درون آن نوشتیم.



The screenshot shows a Linux desktop environment. On the left is a vertical dock with icons for Firefox, a mail client, a file manager, a CD/DVD player, a document viewer, the App Store, a help icon, and an application icon labeled 'a'. The top of the window has a title bar with 'Activities', 'Text Editor', the date 'Oct 19 06:14', and system icons for help, volume, and power. The text editor window is titled 'Makefile' and shows the path '~/Desktop/my\_dir'. It contains the following text:

```
obj-m += simple.o

all:
    make -C /lib/modules/$(shell uname -r)/build M=$(PWD) modules

clean:
    make -C /lib/modules/$(shell uname -r)/build M=$(PWD) clean
```

The status bar at the bottom of the window displays 'Loading file "/home/helia/Desktop/m...', 'Makefile', 'Tab Width: 8', 'Ln 8, Col 1', and 'INS'.

3. با استفاده از دستور lsmod تمام ماژول های موجود را نمایش می دهیم و همانطور که می بینیم فایل ساخته شده هنوز در بین لیست

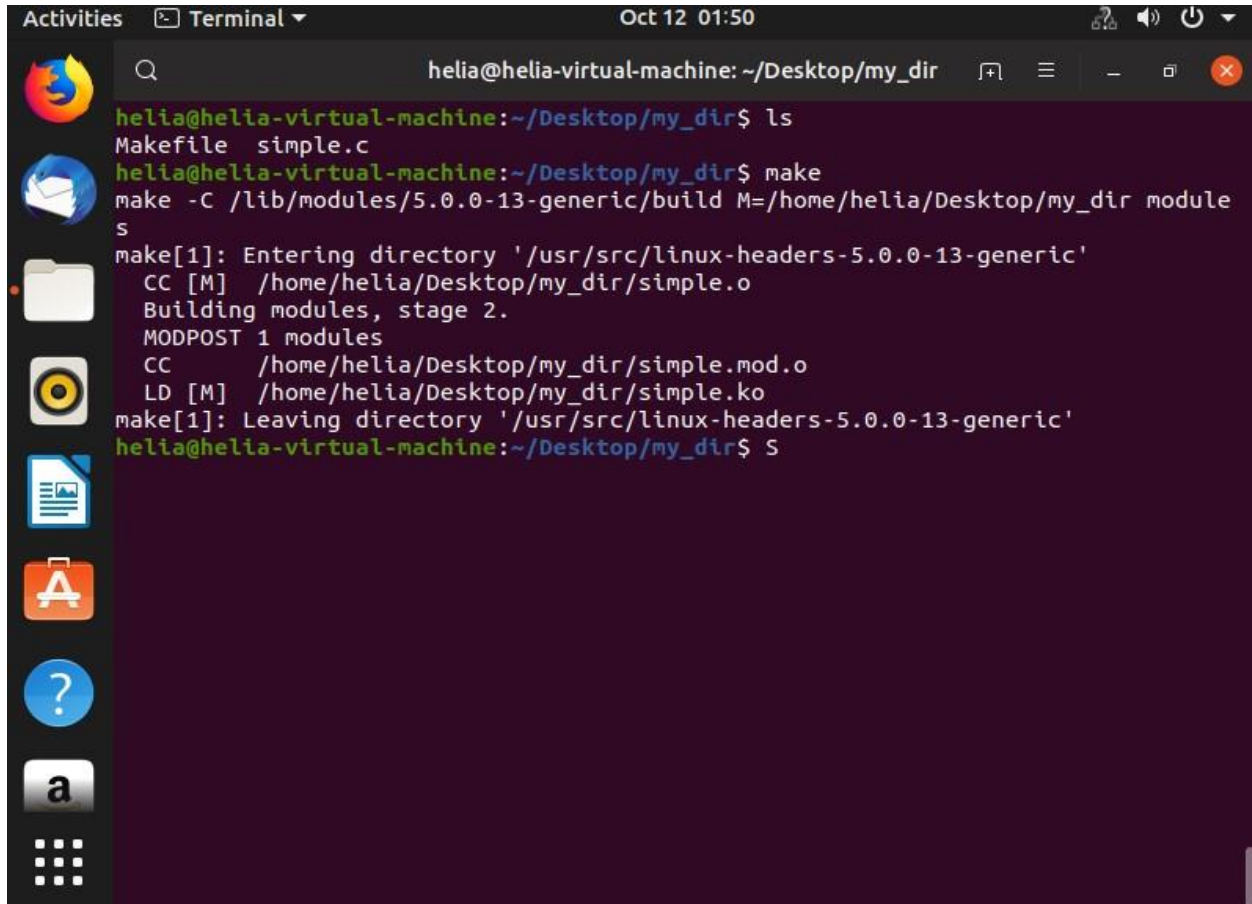
ما نیست.

```
Oct 11 11:41
heliah@heliah-virtual-machine: ~
heliah@heliah-virtual-machine:~$ lsmod
Module              Size  Used by
nls_utf8            16384  1
iso9660             49152  1
rfcomm              77824  0
bnep                24576  2
snd_ens1371         28672  2
snd_ac97_codec     135168  1 snd_ens1371
gameport            20480  1 snd_ens1371
ac97_bus            16384  1 snd_ac97_codec
snd_pcm             102400  2 snd_ac97_codec,snd_ens1371
snd_seq_midi        20480  0
snd_seq_midi_event  16384  1 snd_seq_midi
snd_rawmidi         36864  2 snd_seq_midi,snd_ens1371
crc10dif_pclmul    16384  1
crc32_pclmul        16384  0
ghash_clmulnt_intel 16384  0
snd_seq            69632  2 snd_seq_midi,snd_seq_midi_event
aesni_intel        372736  0
aes_x86_64          20480  1 aesni_intel
snd_seq_device      16384  3 snd_seq,snd_seq_midi,snd_rawmidi
crypto_simd         16384  1 aesni_intel
snd_timer           36864  2 snd_seq,snd_pcm
cryptd              24576  3 crypto_simd,ghash_clmulnt_intel,aesni_intel
vmwgfx              290816  3
glue_helper         16384  1 aesni_intel
snd                 81920  11 snd_seq,snd_seq_device,snd_timer,snd_ac97_codec
c,snd_pcm,snd_rawmidi,snd_ens1371
intel_rapl_perf     16384  0

Oct 11 11:42
heliah@heliah-virtual-machine: ~
joydev              24576  0
vmw_balloon         24576  0
ttm                 102400  1 vmwgfx
soundcore           16384  1 snd
input_leds          16384  0
btusb               49152  0
drm_kms_helper      180224  1 vmwgfx
btrtl               20480  1 btusb
serio_raw           20480  0
btbcm               16384  1 btusb
btintel             24576  1 btusb
drm                 475136  6 vmwgfx,drm_kms_helper,ttm
bluetooth           557056  14 btrtl,btintel,btbcm,bnep,btusb,rfcomm
fb_sys_fops         16384  1 drm_kms_helper
syscopyarea         16384  1 drm_kms_helper
sysfillrect         16384  1 drm_kms_helper
ecdh_generic        28672  1 bluetooth
sysimgblt           16384  1 drm_kms_helper
vmw_vmci            69632  1 vmw_balloon
mac_hid             16384  0
sch_fq_codel        20480  2
parport_pc          40960  0
ppdev               24576  0
lp                  20480  0
parport             53248  3 parport_pc,lp,ppdev
ip_tables           28672  0
x_tables            40960  1 ip_tables
autofs4             45056  2
hid_generic         16384  0

Oct 11 11:43
heliah@heliah-virtual-machine: ~
syscopyarea         16384  1 drm_kms_helper
sysfillrect         16384  1 drm_kms_helper
ecdh_generic        28672  1 bluetooth
sysimgblt           16384  1 drm_kms_helper
vmw_vmci            69632  1 vmw_balloon
mac_hid             16384  0
sch_fq_codel        20480  2
parport_pc          40960  0
ppdev               24576  0
lp                  20480  0
parport             53248  3 parport_pc,lp,ppdev
ip_tables           28672  0
x_tables            40960  1 ip_tables
autofs4             45056  2
hid_generic         16384  0
psmouse            151552  0
mptspt              24576  1
mptscsih            36864  1 mptspt
mptbase             94208  2 mptspt,mptscsih
pcnet32             45056  0
ahci                40960  1
libahci             32768  1 ahci
mii                 16384  1 pcnet32
scsi_transport_spt  32768  1 mptspt
i2c_piix4           28672  0
pata_acpi           16384  0
usbhid              53248  0
hid                 126976  2 usbhid,hid_generic
heliah@heliah-virtual-machine:~$
```

4. با استفاده از دستور `make` فایل `c`. را کامپایل می کنیم. در نتیجه یک فایل `ko`. به ما می دهد.



The image shows a terminal window titled "Terminal" with the date and time "Oct 12 01:50". The prompt is "helia@helia-virtual-machine: ~/Desktop/my\_dir". The user enters the command `ls`, and the output is `Makefile simple.c`. Then, the user enters `make`, and the output shows the compilation process: `make -C /lib/modules/5.0.0-13-generic/build M=/home/helia/Desktop/my_dir module s`, `make[1]: Entering directory '/usr/src/linux-headers-5.0.0-13-generic'`, `CC [M] /home/helia/Desktop/my_dir/simple.o`, `Building modules, stage 2.`, `MODPOST 1 modules`, `CC /home/helia/Desktop/my_dir/simple.mod.o`, `LD [M] /home/helia/Desktop/my_dir/simple.ko`, `make[1]: Leaving directory '/usr/src/linux-headers-5.0.0-13-generic'`, and finally `helia@helia-virtual-machine:~/Desktop/my_dir$ S`. The terminal window has a sidebar with icons for Activities, Terminal, and various applications.

```
helia@helia-virtual-machine: ~/Desktop/my_dir
helia@helia-virtual-machine:~/Desktop/my_dir$ ls
Makefile simple.c
helia@helia-virtual-machine:~/Desktop/my_dir$ make
make -C /lib/modules/5.0.0-13-generic/build M=/home/helia/Desktop/my_dir module s
make[1]: Entering directory '/usr/src/linux-headers-5.0.0-13-generic'
CC [M] /home/helia/Desktop/my_dir/simple.o
Building modules, stage 2.
MODPOST 1 modules
CC /home/helia/Desktop/my_dir/simple.mod.o
LD [M] /home/helia/Desktop/my_dir/simple.ko
make[1]: Leaving directory '/usr/src/linux-headers-5.0.0-13-generic'
helia@helia-virtual-machine:~/Desktop/my_dir$ S
```

5. دستور `insmod` را نوشته (در واقع این دستور ماژول های هسته را بارگذاری می کند) و اگر `lsmod` را بزنییم این بار مشاهده

می کنیم که فایل مورد نظر ما در ماژول ها وجود دارد.

```
Oct 12 01:54
helias@helias-virtual-machine: ~/Desktop/my_dir
helias@helias-virtual-machine:~/Desktop/my_dir$ sudo insmod simple.ko
[sudo] password for helias:
helias@helias-virtual-machine:~/Desktop/my_dir$ lsmod
Module              Size  Used by
simple                16384  0
nls_utf8             16384  1
isofs                49152  1
rfcomm               77824  0
bnep                 24576  2
snd_ens1371          28672  2
snd_ac97_codec       135168  1 snd_ens1371
gameport             20480  1 snd_ens1371
ac97_bus             16384  1 snd_ac97_codec
snd_pcm              102400  2 snd_ac97_codec,snd_ens1371
snd_seq_midi         20480  0
snd_seq_midi_event   16384  1 snd_seq_midi
snd_rawmidi          36864  2 snd_seq_midi,snd_ens1371
crct10dif_pclmul     16384  1
crc32_pclmul         16384  0
ghash_clmulni_intel  16384  0
snd_seq              69632  2 snd_seq_midi,snd_seq_midi_event
aesni_intel          372736  0
aes_x86_64           20480  1 aesni_intel
snd_seq_device        16384  3 snd_seq,snd_seq_midi,snd_rawmidi
crypto_simd           16384  1 aesni_intel
snd_timer            36864  2 snd_seq,snd_pcm
cryptd                24576  3 crypto_simd,ghash_clmulni_intel,aesni_intel
vmwgfx               290816  3
glue_helper           16384  1 aesni_intel
```

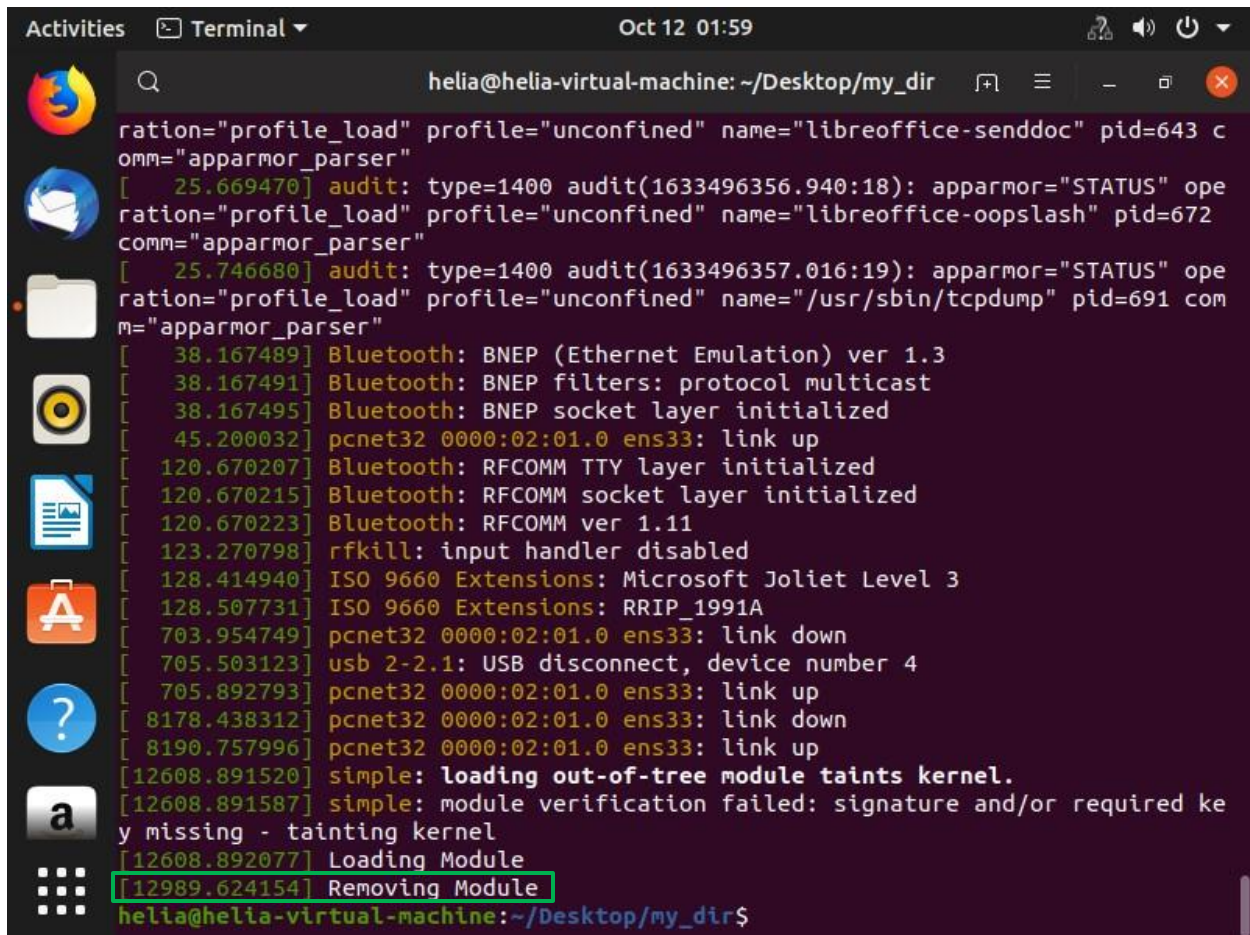


6. دستور dmesg را می نویسیم (دستوری که محتوای بافر را نمایش می دهد) و همانطور که می بینیم پیام مورد نظر که هنگام load

باید نشان داده شود ، در بافر موجود می باشد.

```
Activities Terminal Oct 12 01:56 helia@helia-virtual-machine: ~/Desktop/my_dir
[ 25.522645] audit: type=1400 audit(1633496356.792:17): apparmor="STATUS" operation="profile_load" profile="unconfined" name="libreoffice-senddoc" pid=643 comm="apparmor_parser"
[ 25.669470] audit: type=1400 audit(1633496356.940:18): apparmor="STATUS" operation="profile_load" profile="unconfined" name="libreoffice-oopslash" pid=672 comm="apparmor_parser"
[ 25.746680] audit: type=1400 audit(1633496357.016:19): apparmor="STATUS" operation="profile_load" profile="unconfined" name="/usr/sbin/tcpdump" pid=691 comm="apparmor_parser"
[ 38.167489] Bluetooth: BNEP (Ethernet Emulation) ver 1.3
[ 38.167491] Bluetooth: BNEP filters: protocol multicast
[ 38.167495] Bluetooth: BNEP socket layer initialized
[ 45.200032] pcnet32 0000:02:01.0 ens33: link up
[ 120.670207] Bluetooth: RFCOMM TTY layer initialized
[ 120.670215] Bluetooth: RFCOMM socket layer initialized
[ 120.670223] Bluetooth: RFCOMM ver 1.11
[ 123.270798] rfkill: input handler disabled
[ 128.414940] ISO 9660 Extensions: Microsoft Joliet Level 3
[ 128.507731] ISO 9660 Extensions: RRIP_1991A
[ 703.954749] pcnet32 0000:02:01.0 ens33: link down
[ 705.503123] usb 2-2.1: USB disconnect, device number 4
[ 705.892793] pcnet32 0000:02:01.0 ens33: link up
[ 8178.438312] pcnet32 0000:02:01.0 ens33: link down
[ 8190.757996] pcnet32 0000:02:01.0 ens33: link up
[12608.891520] simple: loading out-of-tree module taints kernel.
[12608.891587] simple: module verification failed: signature and/or required key missing - tainting kernel
[12608.892077] Loading Module
helia@helia-virtual-machine:~/Desktop/my_dir$
```

7. با استفاده از دستور `rmmod` ماژول ساخته شده را برمیداریم و سپس `dmesg` را می نویسیم ، می بینیم که پیام مورد نظر ما در بافر نمایش داده شده است.



```
Activities Terminal Oct 12 01:59 helia@helia-virtual-machine: ~/Desktop/my_dir
ration="profile_load" profile="unconfined" name="libreoffice-senddoc" pid=643 c
omm="apparmor_parser"
[ 25.669470] audit: type=1400 audit(1633496356.940:18): apparmor="STATUS" ope
ration="profile_load" profile="unconfined" name="libreoffice-oopslash" pid=672
comm="apparmor_parser"
[ 25.746680] audit: type=1400 audit(1633496357.016:19): apparmor="STATUS" ope
ration="profile_load" profile="unconfined" name="/usr/sbin/tcpdump" pid=691 com
m="apparmor_parser"
[ 38.167489] Bluetooth: BNEP (Ethernet Emulation) ver 1.3
[ 38.167491] Bluetooth: BNEP filters: protocol multicast
[ 38.167495] Bluetooth: BNEP socket layer initialized
[ 45.200032] pcnet32 0000:02:01.0 ens33: link up
[ 120.670207] Bluetooth: RFCOMM TTY layer initialized
[ 120.670215] Bluetooth: RFCOMM socket layer initialized
[ 120.670223] Bluetooth: RFCOMM ver 1.11
[ 123.270798] rfkill: input handler disabled
[ 128.414940] ISO 9660 Extensions: Microsoft Joliet Level 3
[ 128.507731] ISO 9660 Extensions: RRIP_1991A
[ 703.954749] pcnet32 0000:02:01.0 ens33: link down
[ 705.503123] usb 2-2.1: USB disconnect, device number 4
[ 705.892793] pcnet32 0000:02:01.0 ens33: link up
[ 8178.438312] pcnet32 0000:02:01.0 ens33: link down
[ 8190.757996] pcnet32 0000:02:01.0 ens33: link up
[ 12608.891520] simple: loading out-of-tree module taints kernel.
[ 12608.891587] simple: module verification failed: signature and/or required ke
y missing - tainting kernel
[ 12608.892077] Loading Module
[ 12989.624154] Removing Module
helia@helia-virtual-machine: ~/Desktop/my_dir$
```

- اگر قبل از `rmmod` از دستور `sudo dmesg -c` استفاده کنیم بافر ما خالی می‌شد و تنها پیامی که هنگام `unload` به ما نشان داده می‌شد به صورت زیر بود.

```

Oct 19 06:50
helia@helia-virtual-machine: ~/Desktop/OSLab/Q1
fb_sys_fops      16384 1 drm_kms_helper
syscopyarea      16384 1 drm_kms_helper
sysfillrect      16384 1 drm_kms_helper
sysimgblt        16384 1 drm_kms_helper
vmw_vmci         69632 1 vmw_balloon
mac_hid          16384 0
sch_fq_codel     20480 2
parport_pc       40960 0
ppdev            24576 0
lp              20480 0
parport          53248 3 parport_pc,lp,ppdev
ip_tables        28672 0
x_tables         40960 1 ip_tables
autofs4          45056 2
hid_generic      16384 0
usbhid           53248 0
hid              126976 2 usbhid,hid_generic
psmouse          151552 0
mptspi           24576 1
mptscsih         36864 1 mptspi
mptbase          94208 2 mptspi,mptscsih
pcnet32          45056 0
ahci             40960 1
libahci          32768 1 ahci
scsi_transport_spi 32768 1 mptspi
mii              16384 1 pcnet32
i2c_piix4        28672 0
pata_acpi        16384 0
helia@helia-virtual-machine:~/Desktop/OSLab/Q1$ sudo dmesg -c

```

```

make[1]: Leaving directory '/usr/src/linux-headers-5.0.0-15-generic'
helia@helia-virtual-machine:~/Desktop/OSLab/Q1$ dmesg
helia@helia-virtual-machine:~/Desktop/OSLab/Q1$ sudo rmmod simple.ko
helia@helia-virtual-machine:~/Desktop/OSLab/Q1$ dmesg
[58553.003580] Removing Module

```



8. در انتها با زدن `lsmod` پایانی اطمینان حاصل می کنیم که ماژول ساخته شده حذف شده باشد.

```
Activities Terminal Oct 12 02:01 helia@helia-virtual-machine: ~/Desktop/my_dir
helia@helia-virtual-machine:~/Desktop/my_dir$ lsmod
Module              Size  Used by
nls_utf8            16384  1
isofs               49152  1
rfcomm              77824  0
bnep                24576  2
snd_ens1371         28672  2
snd_ac97_codec      135168  1 snd_ens1371
gameport            20480  1 snd_ens1371
ac97_bus            16384  1 snd_ac97_codec
snd_pcm             102400  2 snd_ac97_codec,snd_ens1371
snd_seq_midi        20480  0
snd_seq_midi_event  16384  1 snd_seq_midi
snd_rawmidi         36864  2 snd_seq_midi,snd_ens1371
crct10dif_pclmul    16384  1
crc32_pclmul        16384  0
ghash_clmulni_intel 16384  0
snd_seq             69632  2 snd_seq_midi,snd_seq_midi_event
aesni_intel         372736  0
aes_x86_64          20480  1 aesni_intel
snd_seq_device      16384  3 snd_seq,snd_seq_midi,snd_rawmidi
crypto_simd         16384  1 aesni_intel
snd_timer           36864  2 snd_seq,snd_pcm
cryptd              24576  3 crypto_simd,ghash_clmulni_intel,aesni_intel
vmwgfx              290816  3
glue_helper         16384  1 aesni_intel
snd                 81920  11 snd_seq,snd_seq_device,snd_timer,snd_ac97_code
c,snd_pcm,snd_rawmidi,snd_ens1371
intel_rapl_perf     16384  0
i915                24576  0
```