

НАЦІОНАЛЬНИЙ ТЕХНІЧНИЙ УНІВЕРСИТЕТ УКРАЇНИ
«КИЇВСЬКИЙ ПОЛІТЕХНІЧНИЙ ІНСТИТУТ»
ФАКУЛЬТЕТ ІНФОРМАТИКИ І ОБЧИСЛЮВАЛЬНОЇ ТЕХНІКИ
КАФЕДРА ОБЧИСЛЮВАЛЬНОЇ ТЕХНІКИ

Лабораторна робота №5
з дисципліни «Архітектура комп'ютерів 2»

Виконала:
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Лістинг коду

hello.c

```
#include <linux/init.h>
#include <linux/module.h>
#include <linux/kernel.h>
#include <linux/proc_fs.h>
#include <linux/uaccess.h>

MODULE_AUTHOR("Iryna Stefanovych IV-93");
MODULE_DESCRIPTION("Computer Architecture Lab5");
MODULE_LICENSE("Dual BSD/GPL");

static int amount = 1;
module_param(amount, uint, S_IRUGO);
MODULE_PARM_DESC(times, "Amount of outputting Hello worlds");

static int __init hello_init(void)
{
    uint i = 0;

    if (amount == 0) {
        printk(KERN_WARNING "Entered parameter equals 0");
    } else if (amount >= 5 && amount <= 10) {
        printk(KERN_WARNING "Entered parameter is between 5 and 10");
    } else if (amount > 10) {
        printk(KERN_ERR "Entered parameter is bigger than 10");
        return -EINVAL;
    }

    for (i = 0; i < amount; i++) {
        printk(KERN_EMERG "Hello, world!\n");
    }

    printk(KERN_INFO "Amount: %d\n", amount);

    return 0;
```

```

}

static void __exit hello_exit(void)
{
    /* Do nothing here right now */
}

module_init(hello_init);
module_exit(hello_exit);

```

Makefile

```

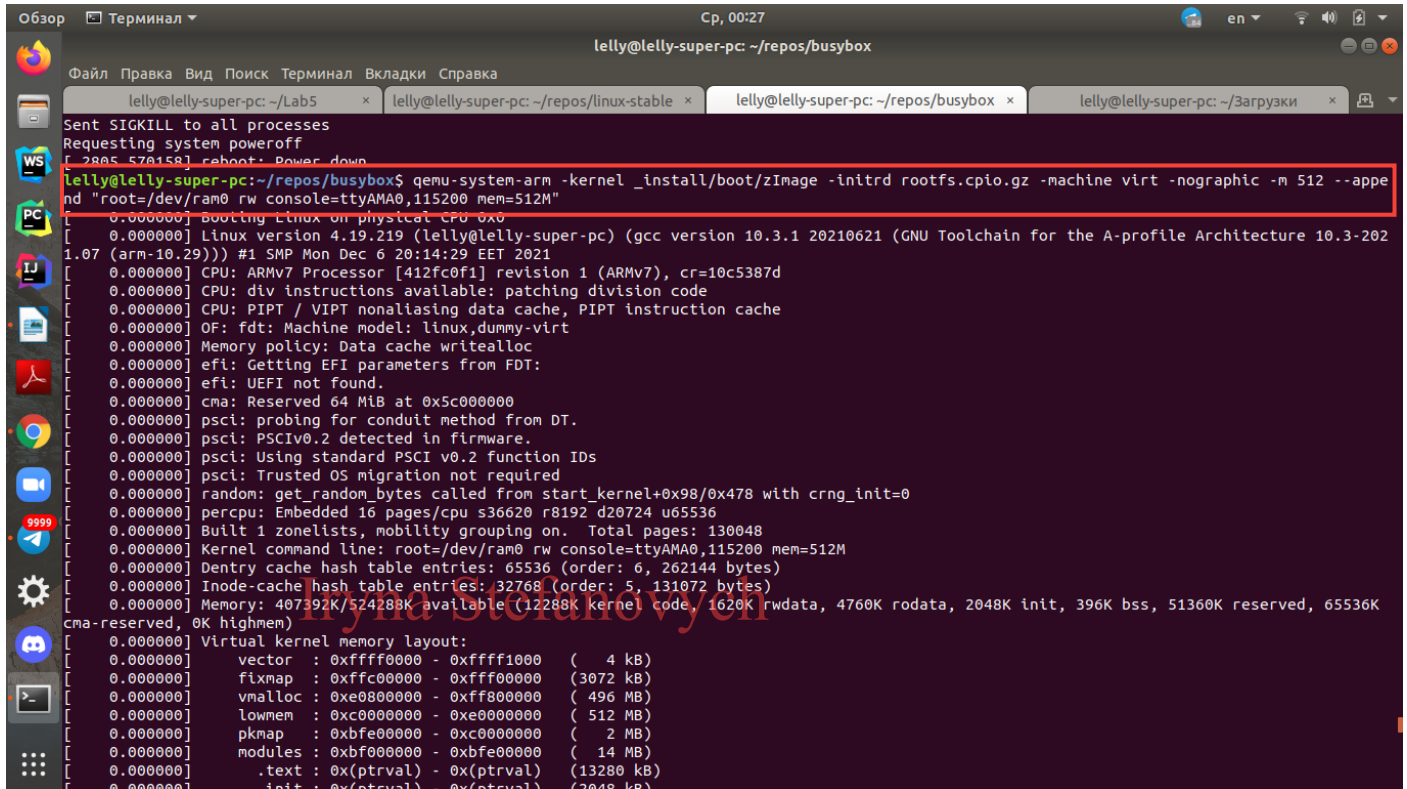
ifndef $(KERNELRELEASE),)
# kbuild part of makefile
obj-m := hello.o
else
# normal makefile
KDIR ?= /lib/modules/`uname -r`/build

default:
    $(MAKE) -C $(KDIR) M=$$PWD
clean:
    $(MAKE) -C $(KDIR) M=$$PWD clean
endif

```

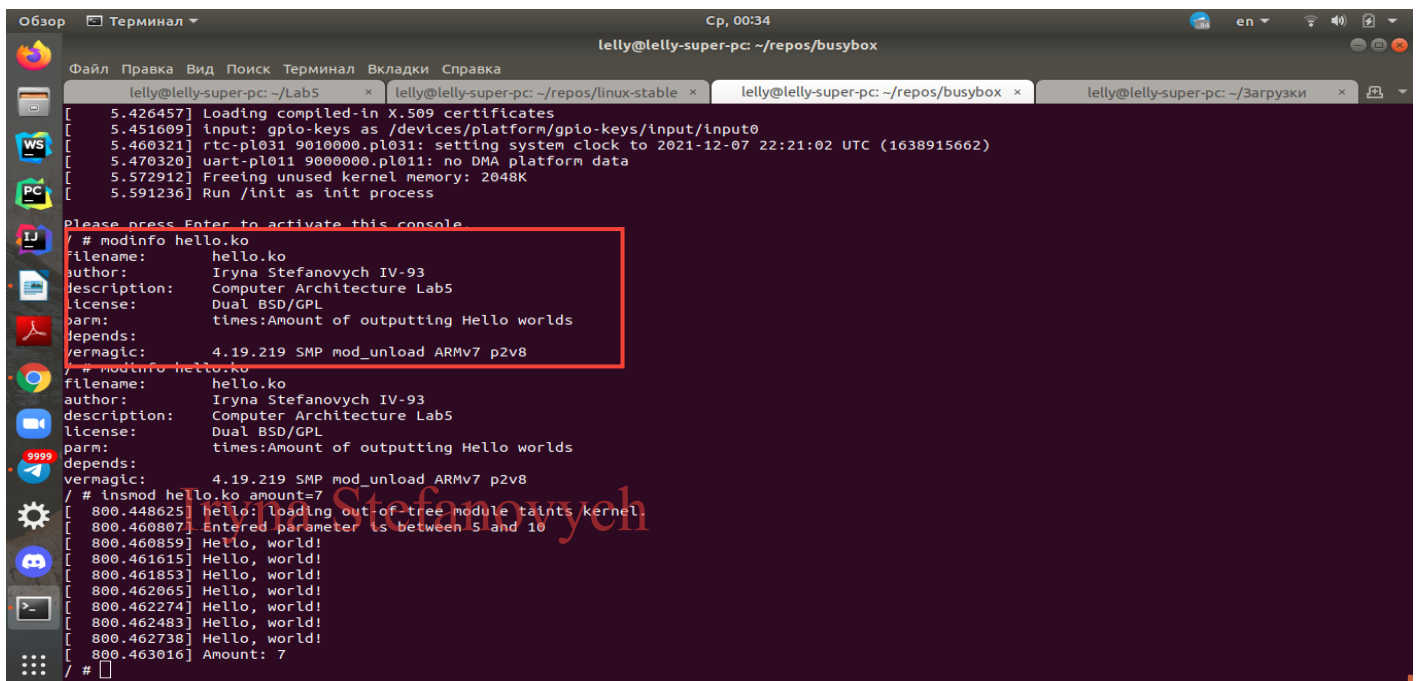
Скріншоти виконання команд

1. Запуск емулятора Qemu:



```
lelly@lelly-super-pc: ~/repos/busybox
Sent SIGKILL to all processes
Requesting system poweroff
[ 2865.570158] reboot: Power down
lelly@lelly-super-pc:~/repos/busybox$ qemu-system-arm -kernel _install/boot/zImage -initrd rootfs.cpio.gz -machine virt -nographic -m 512 --append "root=/dev/ram0 rw console=ttyAMA0,115200 mem=512M"
[ 0.000000] Booting Linux on physical CPU 0x0
[ 0.000000] Linux version 4.19.219 (lelly@lelly-super-pc) (gcc version 10.3.1 20210621 (GNU Toolchain for the A-profile Architecture 10.3-2021.07 (arm-10.29))) #1 SMP Mon Dec 6 20:14:29 EET 2021
[ 0.000000] CPU: ARMv7 Processor [412fc0f1] revision 1 (ARMv7), cr=10c5387d
[ 0.000000] CPU: div instructions available: patching division code
[ 0.000000] CPU: PIPT / VIPT nonaliasing data cache, PIPT instruction cache
[ 0.000000] OF: fdt: Machine model: linux,dummy-virt
[ 0.000000] Memory policy: Data cache writealloc
[ 0.000000] efi: Getting EFI parameters from FDT:
[ 0.000000] efi: UEFI not found.
[ 0.000000] cma: Reserved 64 MiB at 0x5c000000
[ 0.000000] psci: probing for conduit method from DT.
[ 0.000000] psci: PSCIv0.2 detected in firmware.
[ 0.000000] psci: Using standard PSCI v0.2 function IDs
[ 0.000000] psci: Trusted OS migration not required
[ 0.000000] random: get_random_bytes called from start_kernel+0x98/0x478 with crng_init=0
[ 0.000000] percpu: Embedded 16 pages/cpu s36620 r8192 d20724 u65536
[ 0.000000] Built 1 zonelists, mobility grouping on. Total pages: 130048
[ 0.000000] Kernel command line: root=/dev/ram0 rw console=ttyAMA0,115200 mem=512M
[ 0.000000] Dentry cache hash table entries: 65536 (order: 6, 262144 bytes)
[ 0.000000] Inode-cache hash table entries: 32768 (order: 5, 131072 bytes)
[ 0.000000] Memory: 407392K/524288K available (12288K kernel code, 1620K rwdata, 4760K rodata, 2048K init, 396K bss, 51360K reserved, 65536K cma-reserved, 0K highmem)
[ 0.000000] Virtual kernel memory layout:
[ 0.000000] vector : 0xffff0000 - 0xffff1000 ( 4 kB)
[ 0.000000] fixmap : 0xffc00000 - 0xffff0000 (3072 kB)
[ 0.000000] vmalloc : 0xe0000000 - 0xff800000 ( 496 MB)
[ 0.000000] lowmem : 0xc0000000 - 0xe0000000 ( 512 MB)
[ 0.000000] pkmap : 0xbfe00000 - 0xc0000000 ( 2 MB)
[ 0.000000] modules : 0xbfe00000 - 0xbfe00000 ( 14 MB)
[ 0.000000] .text : 0x(ptrval) - 0x(ptrval) (13280 kB)
[ 0.000000] .init : 0x(ptrval) - 0x(ptrval) (2048 kB)
```

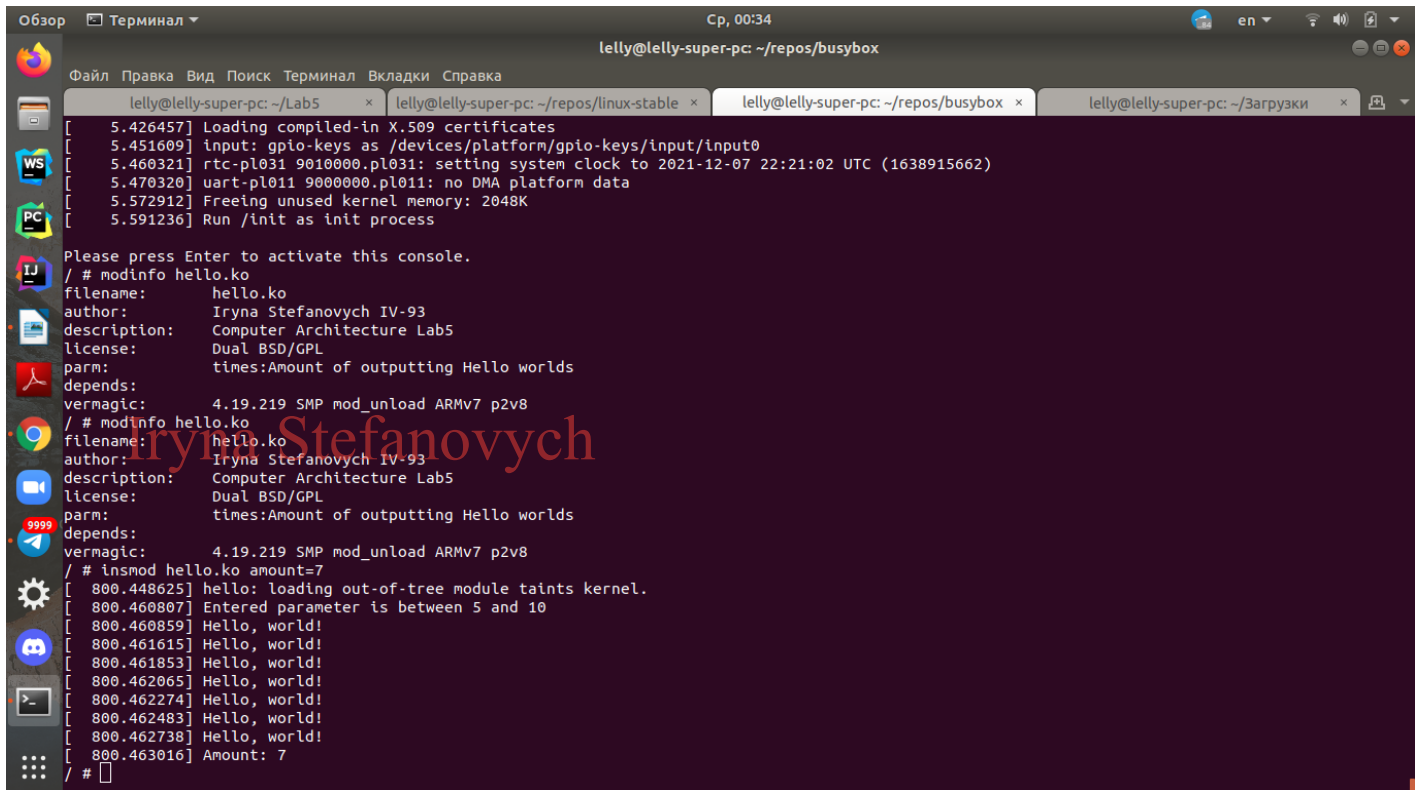
2. Запуск modinfo, параметр за замовчуванням:



```
lelly@lelly-super-pc: ~/repos/busybox
[ 5.426457] Loading compiled-in X.509 certificates
[ 5.451009] input: gpio-keys as /devices/platform/gpio-keys/input/input0
[ 5.460321] rtc-pl031 9010000.pl031: setting system clock to 2021-12-07 22:21:02 UTC (1638915662)
[ 5.470320] uart-pl011 9000000.pl011: no DMA platform data
[ 5.572912] Freeing unused kernel memory: 2048K
[ 5.591236] Run /init as init process

Please press Enter to activate this console.
/ # modinfo hello.ko
filename:      hello.ko
author:       Iryna Stefanovych IV-93
description:   Computer Architecture Lab5
license:      Dual BSD/GPL
parm:         times:Amount of outputting Hello worlds
depends:
vermagic:     4.19.219 SMP mod_unload ARMv7 p2v8
/ # modinfo hello.ko
filename:      hello.ko
author:       Iryna Stefanovych IV-93
description:   Computer Architecture Lab5
license:      Dual BSD/GPL
parm:         times:Amount of outputting Hello worlds
depends:
vermagic:     4.19.219 SMP mod_unload ARMv7 p2v8
/ # insmod hello.ko amount=7
[ 800.448625] hello: loading out-of-tree module taints kernel.
[ 800.460807] Entered parameter is between 5 and 10
[ 800.460859] Hello, world!
[ 800.461615] Hello, world!
[ 800.461853] Hello, world!
[ 800.462065] Hello, world!
[ 800.462274] Hello, world!
[ 800.462483] Hello, world!
[ 800.462738] Hello, world!
[ 800.463016] Amount: 7
/ #
```

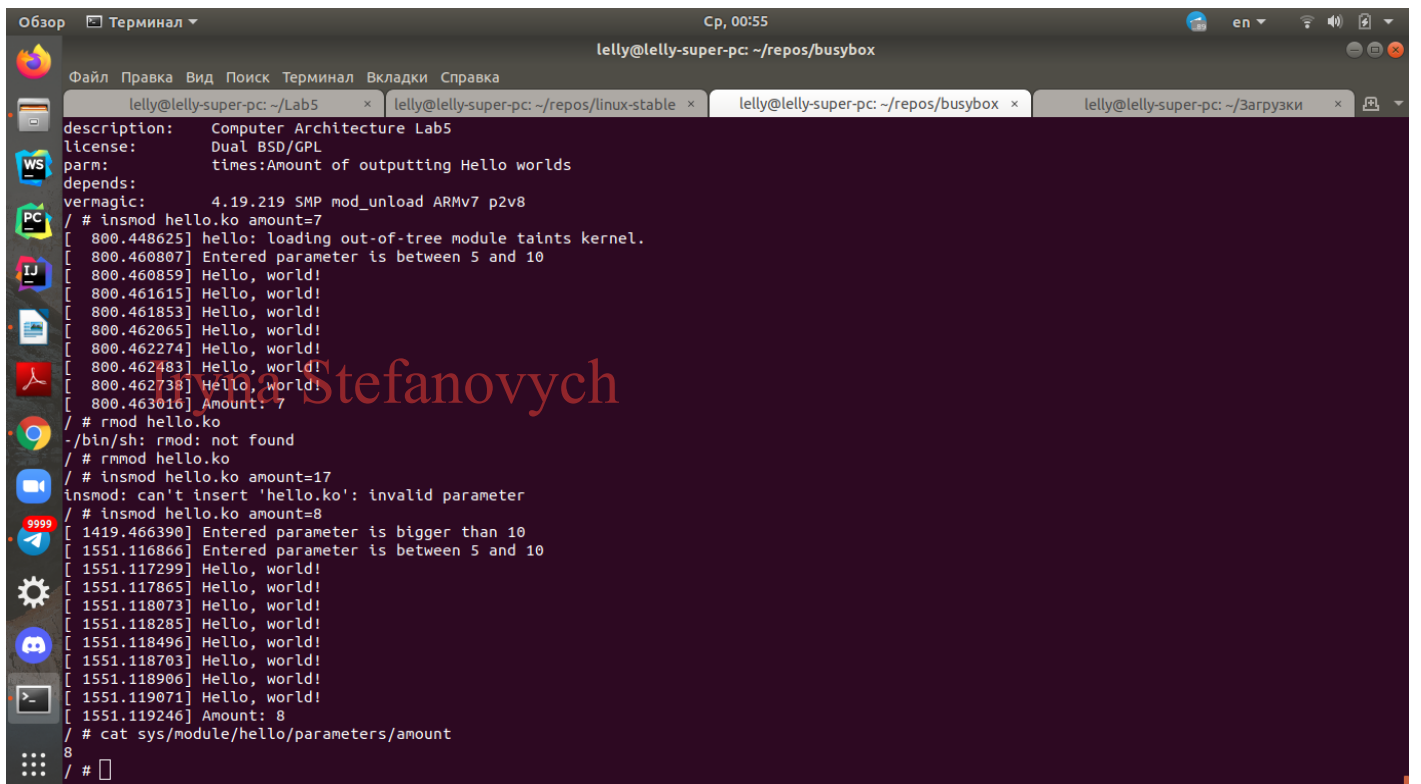
3. Параметр amount знаходиться між 5 і 10:



```
lelly@lelly-super-pc: ~/repos/busybox
[ 5.426457] Loading compiled-in X.509 certificates
[ 5.451609] input: gpio-keys as /devices/platform/gpio-keys/input/input0
[ 5.460321] rtc-pl031 9010000.pl031: setting system clock to 2021-12-07 22:21:02 UTC (1638915662)
[ 5.470320] uart-pl011 9000000.pl011: no DMA platform data
[ 5.572912] Freeing unused kernel memory: 2048K
[ 5.591236] Run /init as init process

Please press Enter to activate this console.
/ # modinfo hello.ko
filename:      hello.ko
author:       Iryna Stefanovych IV-93
description:   Computer Architecture Lab5
license:      Dual BSD/GPL
parm:         times:Amount of outputting Hello worlds
depends:
vermagic:     4.19.219 SMP mod_unload ARMv7 p2v8
/ # modinfo hello.ko
filename:      hello.ko
author:       Iryna Stefanovych IV-93
description:   Computer Architecture Lab5
license:      Dual BSD/GPL
parm:         times:Amount of outputting Hello worlds
depends:
vermagic:     4.19.219 SMP mod_unload ARMv7 p2v8
/ # insmod hello.ko amount=7
[ 800.448625] hello: loading out-of-tree module taints kernel.
[ 800.460807] Entered parameter is between 5 and 10
[ 800.460859] Hello, world!
[ 800.461615] Hello, world!
[ 800.461853] Hello, world!
[ 800.462065] Hello, world!
[ 800.462274] Hello, world!
[ 800.462483] Hello, world!
[ 800.462738] Hello, world!
[ 800.463016] Amount: 7
/ #
```

4. Параметр amount більше 10:



```
lelly@lelly-super-pc: ~/repos/busybox
description:    Computer Architecture Lab5
license:       Dual BSD/GPL
parm:         times:Amount of outputting Hello worlds
depends:
vermagic:     4.19.219 SMP mod_unload ARMv7 p2v8
/ # insmod hello.ko amount=7
[ 800.448625] hello: loading out-of-tree module taints kernel.
[ 800.460807] Entered parameter is between 5 and 10
[ 800.460859] Hello, world!
[ 800.461615] Hello, world!
[ 800.461853] Hello, world!
[ 800.462065] Hello, world!
[ 800.462274] Hello, world!
[ 800.462483] Hello, world!
[ 800.462738] Hello, world!
[ 800.463016] Amount: 7
/ # rmod hello.ko
-/bin/sh: rmod: not found
/ # rmmod hello.ko
/ # insmod hello.ko amount=17
insmod: can't insert 'hello.ko': invalid parameter
/ # insmod hello.ko amount=8
[ 1419.466390] Entered parameter is bigger than 10
[ 1551.116866] Entered parameter is between 5 and 10
[ 1551.117299] Hello, world!
[ 1551.117865] Hello, world!
[ 1551.118073] Hello, world!
[ 1551.118285] Hello, world!
[ 1551.118496] Hello, world!
[ 1551.118703] Hello, world!
[ 1551.118906] Hello, world!
[ 1551.119071] Hello, world!
[ 1551.119246] Amount: 8
/ # cat sys/module/hello/parameters/amount
8
/ #
```

5. Значення встановленого параметру після виконання insmod(параметр 8):

```
Обзор Терминал Cp, 00:53
lelly@lelly-super-pc: ~/repos/busybox

description: Computer Architecture Lab5
license: Dual BSD/GPL
parm: times:Amount of outputting Hello worlds
depends:
vermagic: 4.19.219 SMP mod_unload ARMv7 p2v8
/ # insmod hello.ko amount=7
[ 800.448625] hello: loading out-of-tree module taints kernel.
[ 800.460807] Entered parameter is between 5 and 10
[ 800.460859] Hello, world!
[ 800.461615] Hello, world!
[ 800.461853] Hello, world!
[ 800.462065] Hello, world!
[ 800.462274] Hello, world!
[ 800.462483] Hello, world!
[ 800.462738] Hello, world!
[ 800.463016] Amount: 7
/ # rmod hello.ko
-/bin/sh: rmod: not found
/ # rmmod hello.ko
/ # insmod hello.ko amount=17
insmod: can't insert 'hello.ko': invalid parameter
/ # insmod hello.ko amount=8
[ 1419.466390] Entered parameter is bigger than 10
[ 1551.116866] Entered parameter is between 5 and 10
[ 1551.117299] Hello, world!
[ 1551.117865] Hello, world!
[ 1551.118073] Hello, world!
[ 1551.118285] Hello, world!
[ 1551.118496] Hello, world!
[ 1551.118703] Hello, world!
[ 1551.118906] Hello, world!
[ 1551.119071] Hello, world!
[ 1551.119246] Amount: 8
/ # cat sys/module/hello/parameters/amount
8
/ #
```