

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

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

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Лістинг програми:

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("Dromashko Artem IV-93");
MODULE_DESCRIPTION("AK 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

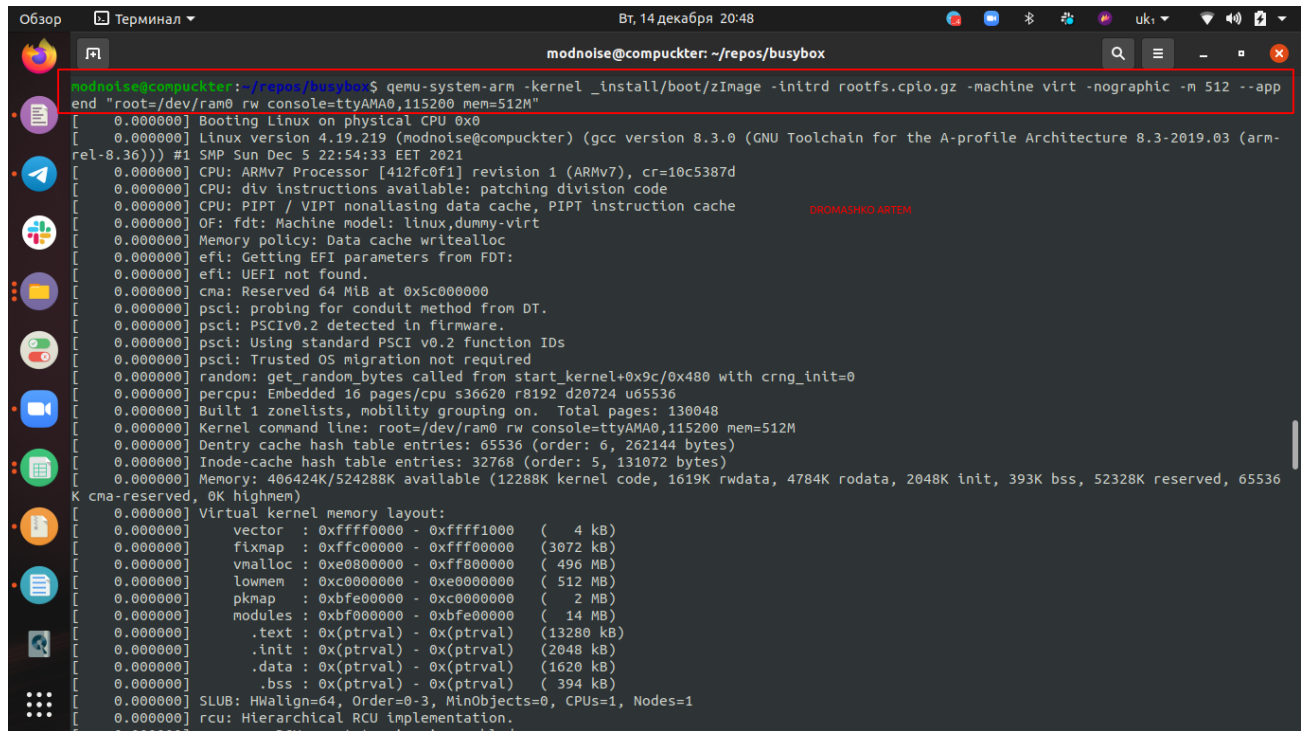
```
ifneq ($(KERNELRELEASE),)
# kbuild part of makefile
obj-m := hello.o
```

```
else
# normal makefile
KDIR ?= /lib/modules/`uname -r`/build

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

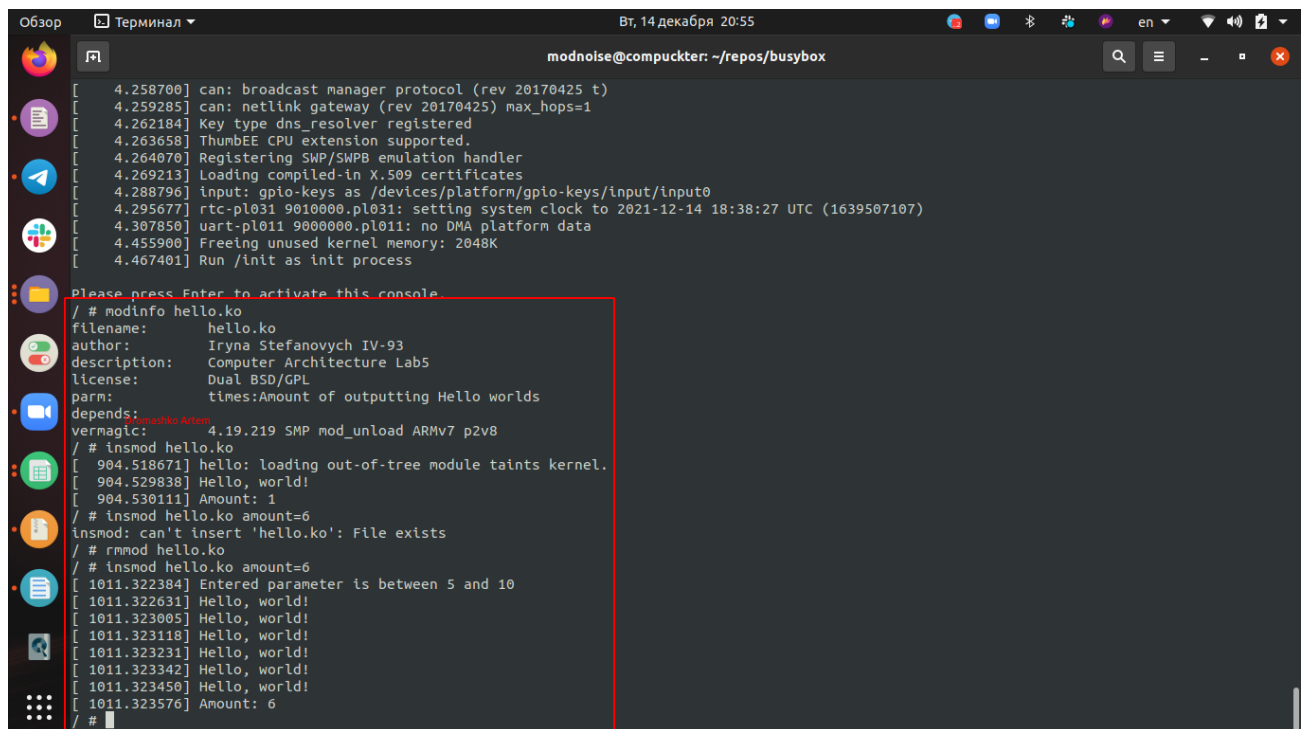
Скріншоти виконання:

1. Запуск эмулятора:



```
modnoise@compuckter: ~/repos/busybox
modnoise@compuckter:~/repos/busybox$ qemu-system-arm -kernel _install/boot/zImage -initrd rootfs.cpio.gz -machine virt -nographic -m 512 --app
end "root=/dev/ram0 rw console=ttyAMA0,115200 mem=512M"
[ 0.000000] Booting Linux on physical CPU 0x0
[ 0.000000] Linux version 4.19.219 (modnoise@compuckter) (gcc version 8.3.0 (GNU Toolchain for the A-profile Architecture 8.3-2019.03 (arm-
rel-8.36))) #1 SMP Sun Dec 5 22:54:33 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] pci: probing for conduit method from DT.
[ 0.000000] pci: PCIv0.2 detected in firmware.
[ 0.000000] pci: Using standard PCI v0.2 function IDs
[ 0.000000] pci: Trusted OS migration not required
[ 0.000000] random: get_random_bytes called from start_kernel+0x9c/0x480 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: 406424K/524288K available (12288K kernel code, 1619K rdata, 4784K rodata, 2048K init, 393K bss, 52328K reserved, 65536
K 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 : 0xe0800000 - 0xffff0000 ( 496 MB)
[ 0.000000] lowmem : 0xc0000000 - 0xe0000000 ( 512 MB)
[ 0.000000] pkmap : 0xbfe00000 - 0xc0000000 ( 2 MB)
[ 0.000000] modules : 0xbf000000 - 0xbfe00000 ( 14 MB)
[ 0.000000] .text : 0x(ptrval) - 0x(ptrval) (13280 kB)
[ 0.000000] .init : 0x(ptrval) - 0x(ptrval) (2048 kB)
[ 0.000000] .data : 0x(ptrval) - 0x(ptrval) (1620 kB)
[ 0.000000] .bss : 0x(ptrval) - 0x(ptrval) ( 394 kB)
[ 0.000000] SLUB: HWalign=64, Order=0-3, MinObjects=0, CPUs=1, Nodes=1
[ 0.000000] rcu: Hierarchical RCU implementation.
[ 0.000000] rcu: RCU uses heap for data.
[ 0.000000] rcu: RCU uses heap for data.
```

2. Запуск modinfo, параметр за замовчуванням, потім amount=6:



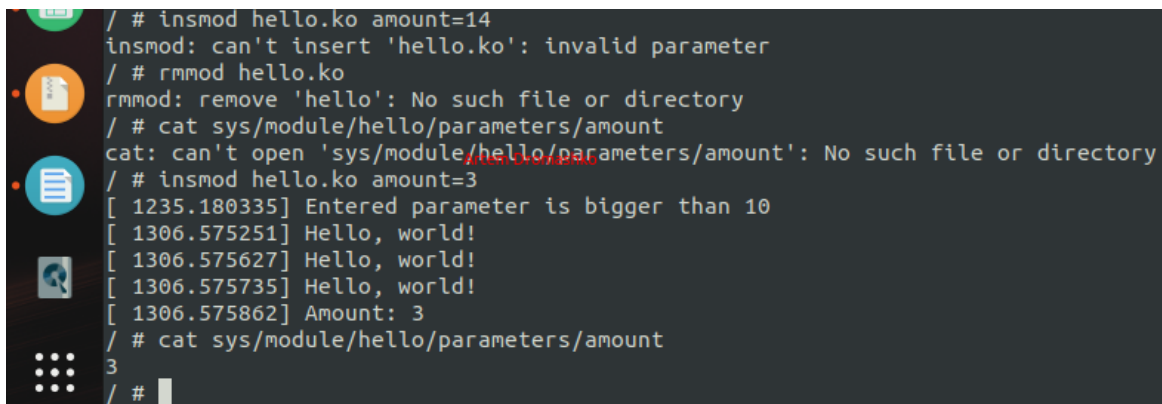
```
modnoise@compuckter: ~/repos/busybox
[ 4.258700] can: broadcast manager protocol (rev 20170425 t)
[ 4.259285] can: netlink gateway (rev 20170425) max_hops=1
[ 4.262184] Key type dns_resolver registered.
[ 4.263658] ThumbEE CPU extension supported.
[ 4.264070] Registering SWP/SWPB emulation handler
[ 4.269213] Loading compiled-in X.509 certificates
[ 4.288796] input: gpio-keys as /devices/platform/gpio-keys/input/input0
[ 4.295677] rtc-pl031 9010000.pl031: setting system clock to 2021-12-14 18:38:27 UTC (1639507107)
[ 4.307850] uart-pl011 9000000.pl011: no DMA platform data
[ 4.455900] Freeing unused kernel memory: 2048K
[ 4.467401] 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 Labs
license:       Dual BSD/GPL
parm:         times:Amount of outputting Hello worlds
depends:
vermagic:      4.19.219 SMP mod_unload ARMv7 p2v8
/ # insmod hello.ko
[ 904.518671] hello: loading out-of-tree module taints kernel.
[ 904.529838] Hello, world!
[ 904.530111] Amount: 1
/ # insmod hello.ko amount=6
insmod: can't insert 'hello.ko': File exists
/ # rmmod hello.ko
/ # insmod hello.ko amount=6
[ 1011.322384] Entered parameter is between 5 and 10
[ 1011.322631] Hello, world!
[ 1011.323005] Hello, world!
[ 1011.323118] Hello, world!
[ 1011.323231] Hello, world!
[ 1011.323342] Hello, world!
[ 1011.323450] Hello, world!
[ 1011.323576] Amount: 6
/ #
```

3. Параметр знаходиться між 5 і 10:

4. Параметр більше 10:

3. Параметр `amount > 10`. Значення встановленого параметру після виконання `insmod`



```
/ # insmod hello.ko amount=14
insmod: can't insert 'hello.ko': invalid parameter
/ # rmmod hello.ko
rmmod: remove 'hello': No such file or directory
/ # cat sys/module/hello/parameters/amount
cat: can't open 'sys/module/hello/parameters/amount': No such file or directory
/ # insmod hello.ko amount=3
[ 1235.180335] Entered parameter is bigger than 10
[ 1306.575251] Hello, world!
[ 1306.575627] Hello, world!
[ 1306.575735] Hello, world!
[ 1306.575862] Amount: 3
/ # cat sys/module/hello/parameters/amount
3
/ #
```