

CSCI 4401

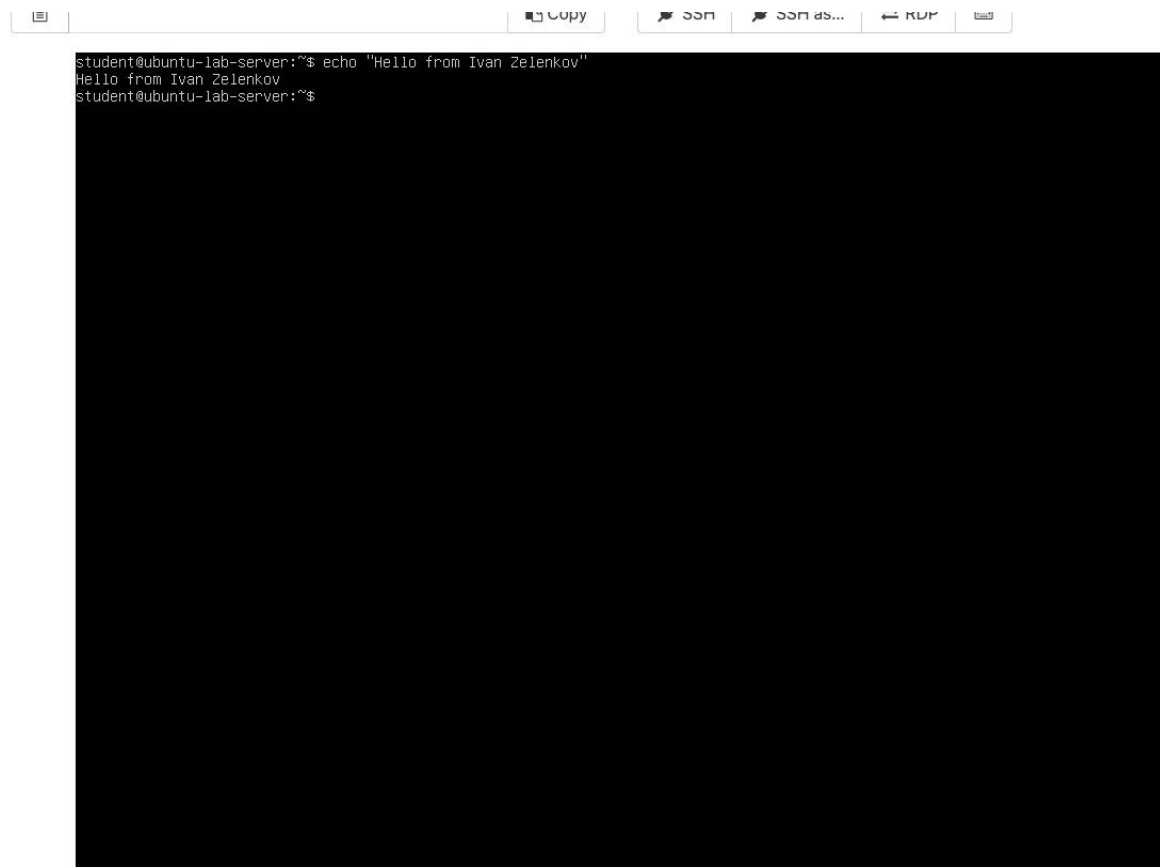
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Assignment 1

Question 1. Run `$echo "Hello from [your name]"`. Submit a screenshot of your running VM.



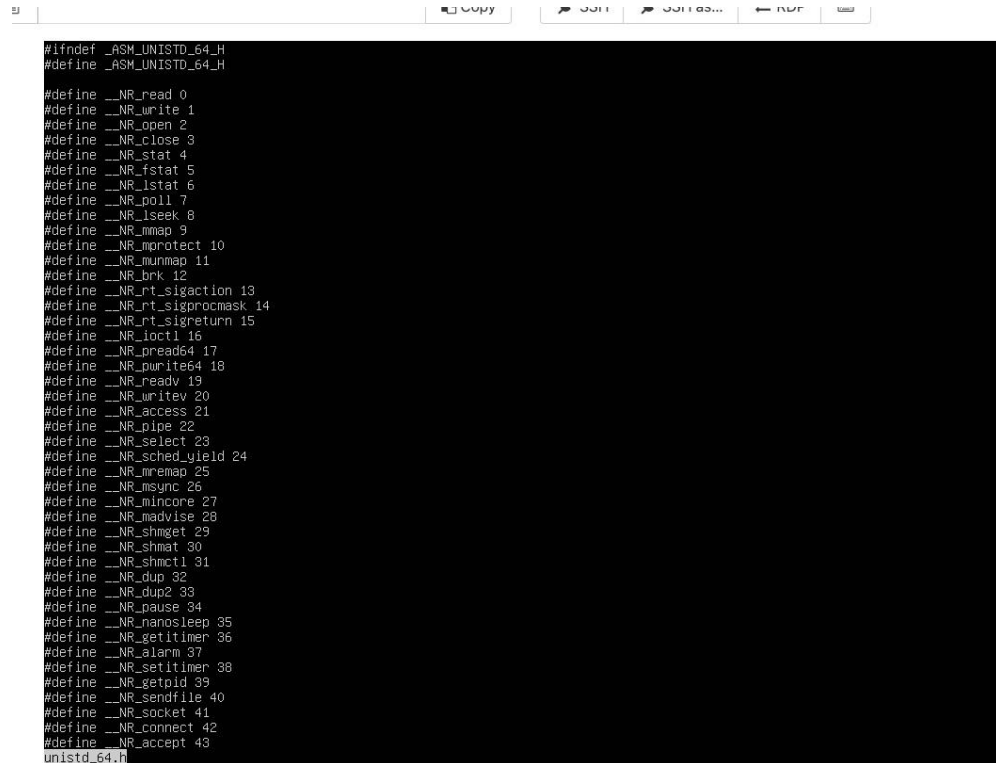
The screenshot shows a terminal window with a dark background. The prompt is `student@ubuntu-lab-server:~$`. The command `echo "Hello from Ivan Zelenkov"` has been entered and executed. The output `Hello from Ivan Zelenkov` is displayed on the next line. The prompt `student@ubuntu-lab-server:~$` is visible again on the third line. The terminal window has a title bar with buttons for Copy, SSH, SSH as..., RDP, and a close button.

```
student@ubuntu-lab-server:~$ echo "Hello from Ivan Zelenkov"
Hello from Ivan Zelenkov
student@ubuntu-lab-server:~$
```

Question 2. What is your current kernel version?

5.15.0-46-generic

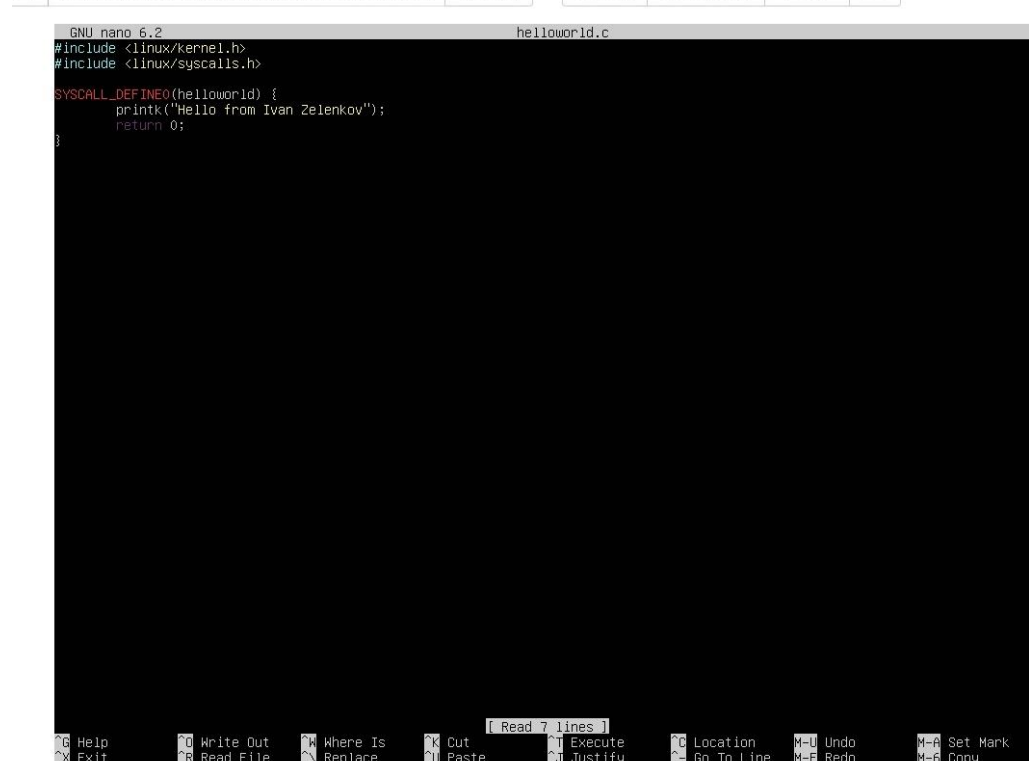
Question 3. Submit a screenshot of at least ten of your system calls.



```
#ifndef _ASM_UNISTD_64_H
#define _ASM_UNISTD_64_H

#define __NR_read 0
#define __NR_write 1
#define __NR_open 2
#define __NR_close 3
#define __NR_stat 4
#define __NR_fstat 5
#define __NR_lstat 6
#define __NR_poll 7
#define __NR_lseek 8
#define __NR_mmap 9
#define __NR_mprotect 10
#define __NR_munmap 11
#define __NR_brk 12
#define __NR_rt_sigaction 13
#define __NR_rt_sigprocmask 14
#define __NR_rt_sigreturn 15
#define __NR_ioctl 16
#define __NR_pread64 17
#define __NR_pwrite64 18
#define __NR_readv 19
#define __NR_writev 20
#define __NR_access 21
#define __NR_pipe 22
#define __NR_select 23
#define __NR_sched_yield 24
#define __NR_mremap 25
#define __NR_msync 26
#define __NR_mincore 27
#define __NR_madvise 28
#define __NR_shmget 29
#define __NR_shmat 30
#define __NR_shmctl 31
#define __NR_dup 32
#define __NR_dup2 33
#define __NR_pause 34
#define __NR_nanosleep 35
#define __NR_getitimer 36
#define __NR_alarm 37
#define __NR_setitimer 38
#define __NR_getpid 39
#define __NR_sendfile 40
#define __NR_socket 41
#define __NR_connect 42
#define __NR_accept 43
unistd_64.h
```

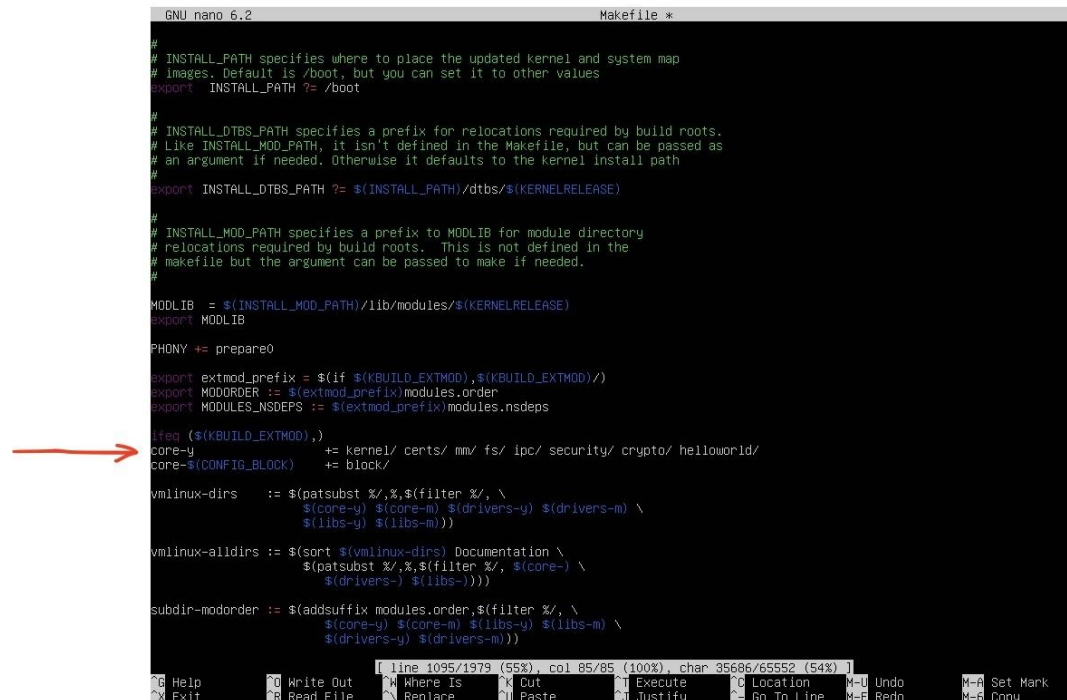
Question 4. Submit a screenshot of your system call code.



```
GNU nano 6.2 helloworld.c
#include <linux/kernel.h>
#include <linux/syscalls.h>

SYSCALL_DEFINE0(helloworld) {
    printk("Hello from Ivan Zelenkov");
    return 0;
}
```

Question 5. Submit a screenshot of your modified Makefile.



```
GNU nano 6.2 Makefile *
#
# INSTALL_PATH specifies where to place the updated kernel and system map
# images. Default is /boot, but you can set it to other values
export INSTALL_PATH ?= /boot
#
# INSTALL_DTBS_PATH specifies a prefix for relocations required by build roots.
# Like INSTALL_MOD_PATH, it isn't defined in the Makefile, but can be passed as
# an argument if needed. Otherwise it defaults to the kernel install path
export INSTALL_DTBS_PATH ?= $(INSTALL_PATH)/dtbs/$(KERNELRELEASE)
#
# INSTALL_MOD_PATH specifies a prefix to MODLIB for module directory
# relocations required by build roots. This is not defined in the
# makefile but the argument can be passed to make if needed.
#
MODLIB = $(INSTALL_MOD_PATH)/lib/modules/$(KERNELRELEASE)
export MODLIB
PHONY += prepare0
export extmod_prefix = $(if $(KBUILD_EXTMOD),$(KBUILD_EXTMOD)/)
export MODORDER := $(extmod_prefix)modules.order
export MODULES_NSDEPS := $(extmod_prefix)modules.nsdeps
ifeq ($(KBUILD_EXTMOD),)
core-y += kernel/ certs/ mm/ fs/ ipc/ security/ crypto/ helloworld/
core-$(CONFIG_BLOCK) += block/

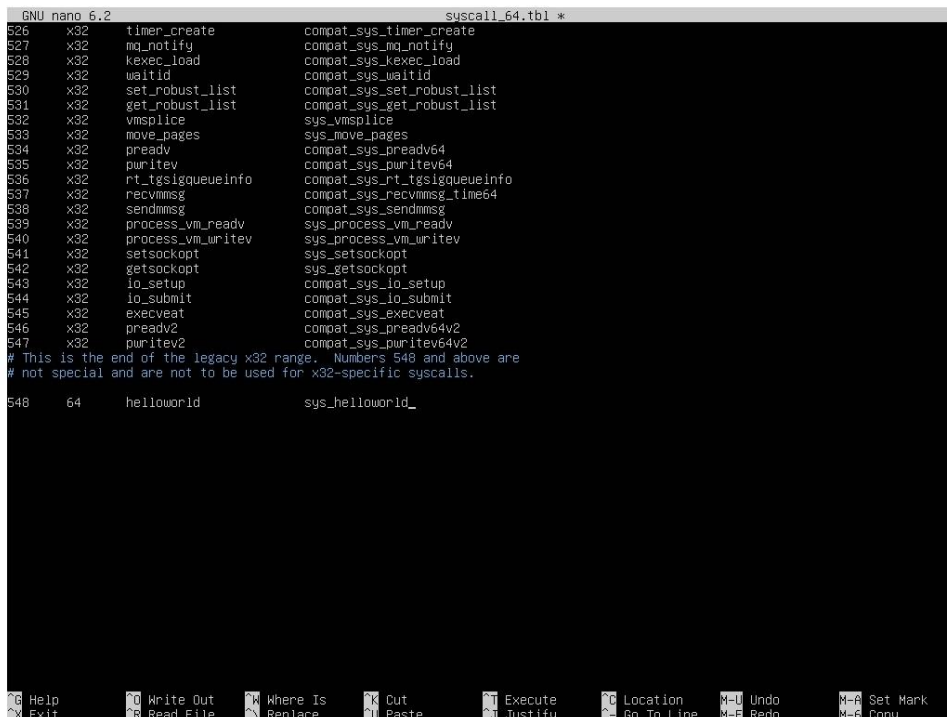
vmlinux-dirs := $(patsubst %/,%, $(filter %/, \
$(core-y) $(core-m) $(drivers-y) $(drivers-m) \
$(libs-y) $(libs-m)))

vmlinux-alldirs := $(sort $(vmlinux-dirs) Documentation \
$(patsubst %/,%, $(filter %/, $(core-) \
$(drivers-) $(libs-))))

subdir-modorder := $(addsuffix modules.order, $(filter %/, \
$(core-y) $(core-m) $(libs-y) $(libs-m) \
$(drivers-y) $(drivers-m)))

line 1095/1979 (55%) col 85/85 (100%) char 35686/65552 (54%)
[?] Help [O] Write Out [X] Where Is [C] Cut [E] Execute [G] Location [M-U] Undo [M-A] Set Mark
[O] Exit [R] Read File [N] Replace [V] Paste [J] Justify [G] Go To Line [M-E] Redo [M-C] Copy
```

Question 6. Submit a screenshot of your syscall_64.tbl that includes your system call.



```
GNU nano 6.2 syscall_64.tbl *
526 x32 timer_create compat_sys_timer_create
527 x32 mq_notify compat_sys_mq_notify
528 x32 kexec_load compat_sys_kexec_load
529 x32 waitid compat_sys_waitid
530 x32 set_robust_list compat_sys_set_robust_list
531 x32 get_robust_list compat_sys_get_robust_list
532 x32 vmsplice sys_vmsplice
533 x32 move_pages sys_move_pages
534 x32 preadv compat_sys_preadv64
535 x32 pwritev compat_sys_pwritev64
536 x32 rt_sigqueueinfo compat_sys_rt_sigqueueinfo
537 x32 recvmsg compat_sys_recvmsg_time64
538 x32 sendmsg compat_sys_sendmsg
539 x32 process_vm_readv sys_process_vm_readv
540 x32 process_vm_writev sys_process_vm_writev
541 x32 setsockopt sys_setsockopt
542 x32 getsockopt sys_getsockopt
543 x32 io_setup compat_sys_io_setup
544 x32 io_submit compat_sys_io_submit
545 x32 execveat compat_sys_execveat
546 x32 preadv2 compat_sys_preadv64v2
547 x32 pwritev2 compat_sys_pwritev64v2
# This is the end of the legacy x32 range. Numbers 548 and above are
# not special and are not to be used for x32-specific syscalls.
548 64 helloworld sys_helloworld_
```

Question 7. Submit a screenshot of your boot directory containing a new kernel config file, System.map, and vmlinuz file.

```
student@ubuntu-lab-server:~/linux-5.16.13$ ls /boot/
config-5.15.0-41-generic  initrd.img-5.15.0-41-generic  System.map-5.15.0-41-generic  vmlinuz-5.15.0-46-generic
config-5.15.0-46-generic  initrd.img-5.15.0-46-generic  System.map-5.15.0-46-generic  vmlinuz-5.16.13
config-5.16.13           initrd.img-5.16.13           System.map-5.16.13           vmlinuz.old
grub                     initrd.img.old               vmlinuz                      vmlinuz-5.15.0-41-generic
initrd.img              lost+found                   vmlinuz-5.15.0-41-generic
```

Question 8. Submit a screenshot that verifies you are using your new kernel version.

```
student@ubuntu-lab-server:~$ uname -r
5.16.13
student@ubuntu-lab-server:~$
```

Question 9. Submit a screenshot of your output from `$dmesg` containing the message from your system call.

```
[ 6.149879] systemd[1]: Starting Load Kernel Modules...
[ 6.155946] systemd[1]: Starting Remount Root and Kernel File Systems...
[ 6.162313] systemd[1]: Starting Coldplug All udev Devices...
[ 6.168392] systemd[1]: Mounted Huge Pages File System.
[ 6.172729] systemd[1]: Started Journal Service.
[ 6.200476] EXT4-fs (dm-0): re-mounted. Opts: (null). Quota mode: none.
[ 6.243776] Adding 2297852k swap on /swap.img. Priority:-2 extents:4 across:
2527228k
[ 6.253207] systemd-journald[317]: Received client request to flush runtime j
ournal.
[ 6.357198] systemd-journald[317]: File /var/log/journal/d3c5c5aace7e4042afc1
e38e60359b4c/system.journal corrupted or uncleanly shut down, renaming and repla
cing.
[ 6.806371] loop0: detected capacity change from 0 to 126896
[ 6.808214] loop1: detected capacity change from 0 to 126888
[ 6.827385] loop0: detected capacity change from 0 to 163736
[ 6.838095] loop0: detected capacity change from 0 to 91496
[ 6.850317] loop0: detected capacity change from 0 to 96176
[ 7.599299] EXT4-fs (sda2): mounted filesystem with ordered data mode. Opts:
(null). Quota mode: none.
[ 9.134321] cloud-init (567) used greatest stack depth: 13040 bytes left
[ 11.766607] loop0: detected capacity change from 0 to 8
[ 89.921672] Hello from Ivan Zelenkov
[ 311.777182] loop0: detected capacity change from 0 to 8
student@ubuntu-lab-server:~/linux-5.16.13/helloworld$ _
```