

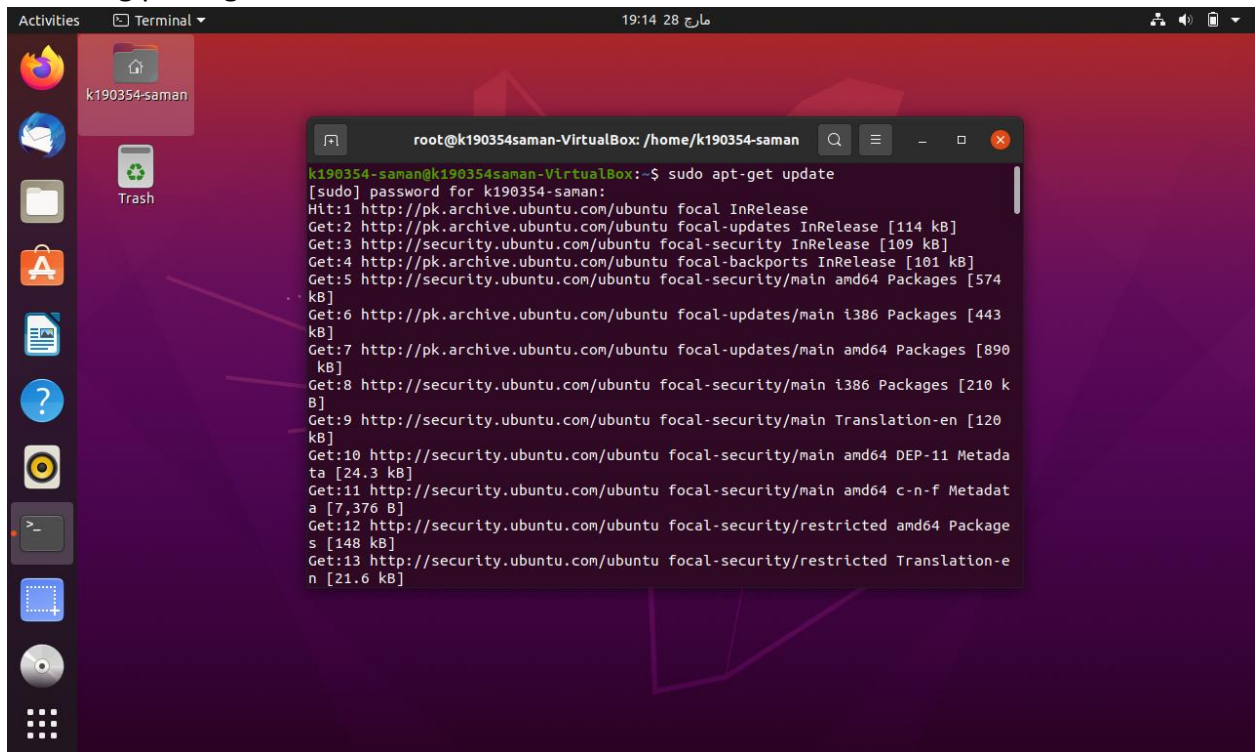
OS THEORY ASSIGNMENT

Name: Saman Khan

ID: 19K-0354

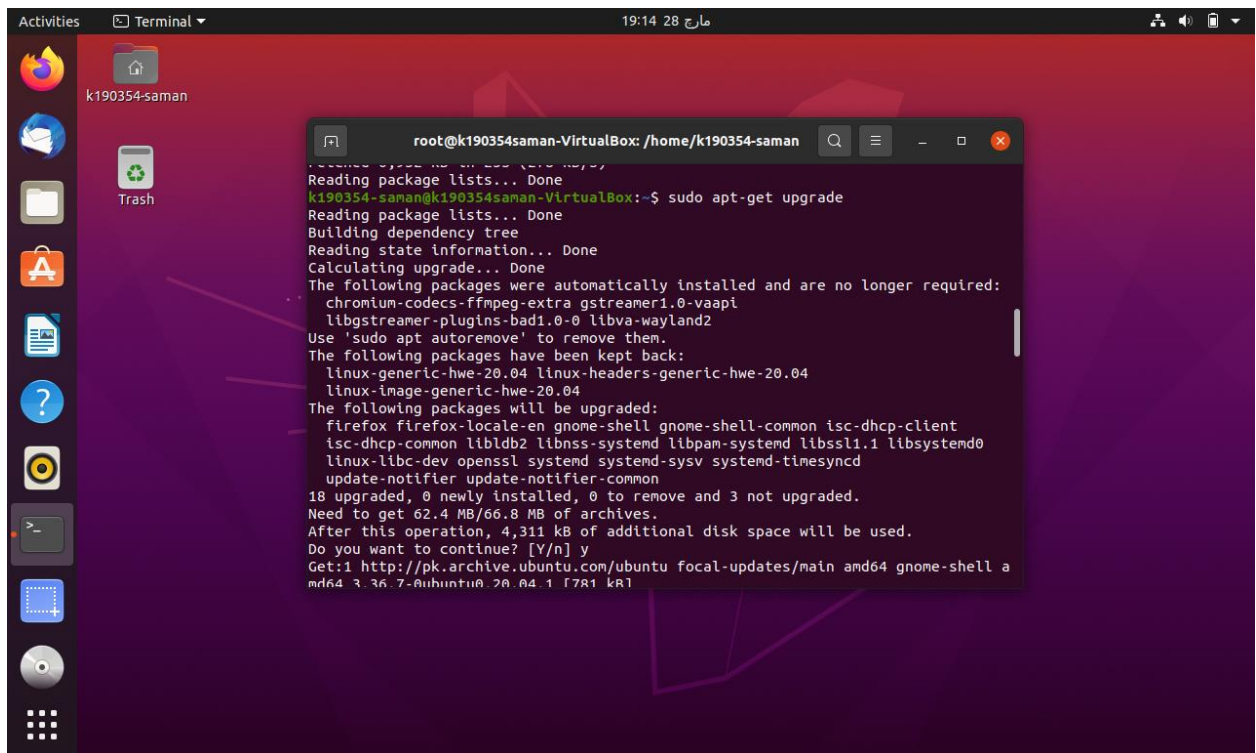
Section: H

- Installing packages:

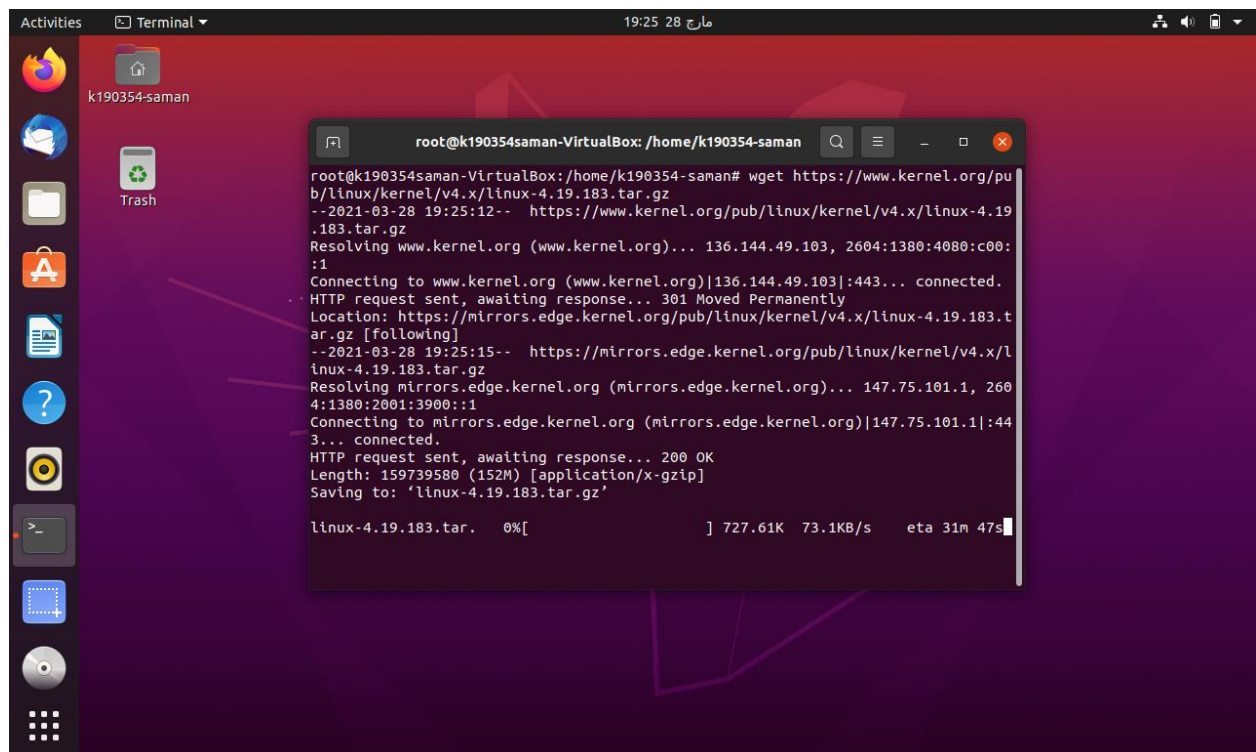


The screenshot shows a Linux desktop environment with a dark theme. A terminal window is open, displaying the command `sudo apt-get update` and its output. The output lists various Ubuntu repositories and the packages being updated, including focal-updates, focal-security, and focal-backports. The desktop background is a dark red/purple gradient. The terminal window title is `root@k190354saman-VirtualBox: /home/k190354-saman`.

```
root@k190354saman-VirtualBox: /home/k190354-saman
k190354-saman@k190354saman-VirtualBox:~$ sudo apt-get update
[sudo] password for k190354-saman:
Hit:1 http://pk.archive.ubuntu.com/ubuntu focal InRelease
Get:2 http://pk.archive.ubuntu.com/ubuntu focal-updates InRelease [114 kB]
Get:3 http://security.ubuntu.com/ubuntu focal-security InRelease [109 kB]
Get:4 http://pk.archive.ubuntu.com/ubuntu focal-backports InRelease [101 kB]
Get:5 http://security.ubuntu.com/ubuntu focal-security/main amd64 Packages [574 kB]
Get:6 http://pk.archive.ubuntu.com/ubuntu focal-updates/main i386 Packages [443 kB]
Get:7 http://pk.archive.ubuntu.com/ubuntu focal-updates/main amd64 Packages [890 kB]
Get:8 http://security.ubuntu.com/ubuntu focal-security/main i386 Packages [210 kB]
Get:9 http://security.ubuntu.com/ubuntu focal-security/main Translation-en [120 kB]
Get:10 http://security.ubuntu.com/ubuntu focal-security/main amd64 DEP-11 Metadata [24.3 kB]
Get:11 http://security.ubuntu.com/ubuntu focal-security/main amd64 c-n-f Metadata [7,376 B]
Get:12 http://security.ubuntu.com/ubuntu focal-security/restricted amd64 Packages [148 kB]
Get:13 http://security.ubuntu.com/ubuntu focal-security/restricted Translation-en [21.6 kB]
```



- Downloading the kernel file:



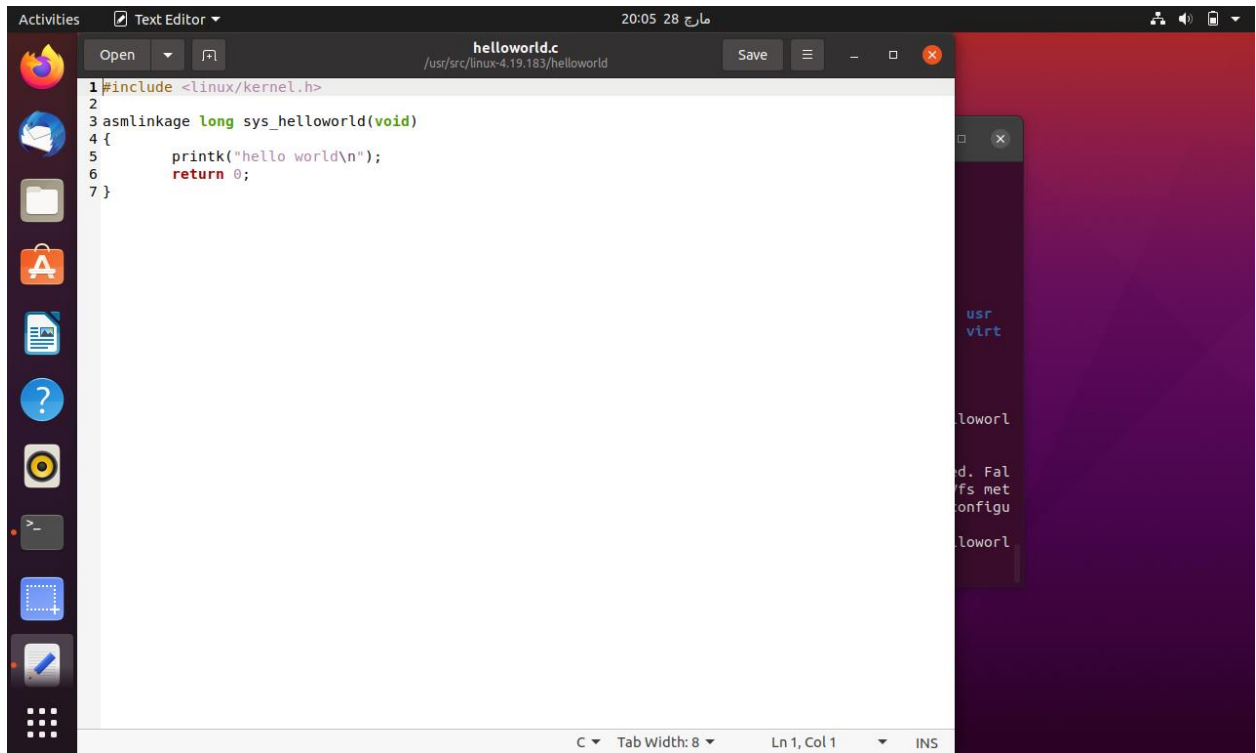
- Extracting the kernel file:

The screenshot shows a Linux desktop with a terminal window open. The terminal title is "root@k190354saman-VirtualBox: /home/k190354-saman". The terminal displays a list of files in the directory /home/k190354-saman, which includes various kernel source files for Linux 4.19.183, such as `linux-4.19.183/virt/kvm/arm/vgic/vgic-mmio.c`, `linux-4.19.183/virt/kvm/arm/vgic/vgic-mmio.h`, `linux-4.19.183/virt/kvm/arm/vgic/vgic-v2.c`, `linux-4.19.183/virt/kvm/arm/vgic/vgic-v3.c`, `linux-4.19.183/virt/kvm/arm/vgic/vgic-v4.c`, `linux-4.19.183/virt/kvm/arm/vgic/vgic.c`, `linux-4.19.183/virt/kvm/arm/vgic/vgic.h`, `linux-4.19.183/virt/kvm/async_pf.c`, `linux-4.19.183/virt/kvm/async_pf.h`, `linux-4.19.183/virt/kvm/coalesced_mmio.c`, `linux-4.19.183/virt/kvm/coalesced_mmio.h`, `linux-4.19.183/virt/kvm/eventfd.c`, `linux-4.19.183/virt/kvm/irqchip.c`, `linux-4.19.183/virt/kvm/kvm_main.c`, `linux-4.19.183/virt/kvm/vfio.c`, `linux-4.19.183/virt/kvm/vfio.h`, `linux-4.19.183/virt/lib/`, `linux-4.19.183/virt/lib/Kconfig`, `linux-4.19.183/virt/lib/Makefile`, and `linux-4.19.183/virt/lib/irqbypass.c`. Below the list, the terminal shows the command `ls` and the output of the `ls` command, which lists the contents of the /home/k190354-saman directory, including Desktop, Downloads, Music, Pictures, Q1.cpp, Q5.cpp, Videos, Documents, linux-4.19.183.tar.gz, obj, Public, Q4.cpp, and Templates.

- Creating a new directory helloworld:

The screenshot shows a Linux desktop with a terminal window open. The terminal title is "root@k190354saman-VirtualBox: /usr/src/linux-4.19.183/hell...". The terminal displays a list of files in the directory /usr/src/linux-4.19.183, which includes `linux-4.19.183`, `linux-headers-5.8.0-43-generic`, `linux-headers-5.8.0-45-generic`, `linux-hwe-5.8-headers-5.8.0-43`, and `linux-hwe-5.8-headers-5.8.0-45`. Below the list, the terminal shows the command `ls` and the output of the `ls` command, which lists the contents of the /usr/src directory, including arch, CREDITS, firmware, ipc, lib, mm, scripts, and usr. The terminal then shows the command `cd /usr/src` and the output of the `ls` command, which lists the contents of the /usr/src directory, including arch, CREDITS, firmware, ipc, lib, mm, scripts, and usr. The terminal then shows the command `cd linux-4.19.183` and the output of the `ls` command, which lists the contents of the /usr/src/linux-4.19.183 directory, including arch, CREDITS, firmware, ipc, lib, mm, scripts, and usr. The terminal then shows the command `mkdir helloworld` and the output of the `ls` command, which lists the contents of the /usr/src/linux-4.19.183 directory, including arch, CREDITS, firmware, ipc, lib, mm, scripts, and usr. The terminal then shows the command `cd helloworld` and the output of the `ls` command, which lists the contents of the /usr/src/linux-4.19.183/helloworld directory, including arch, CREDITS, firmware, ipc, lib, mm, scripts, and usr.

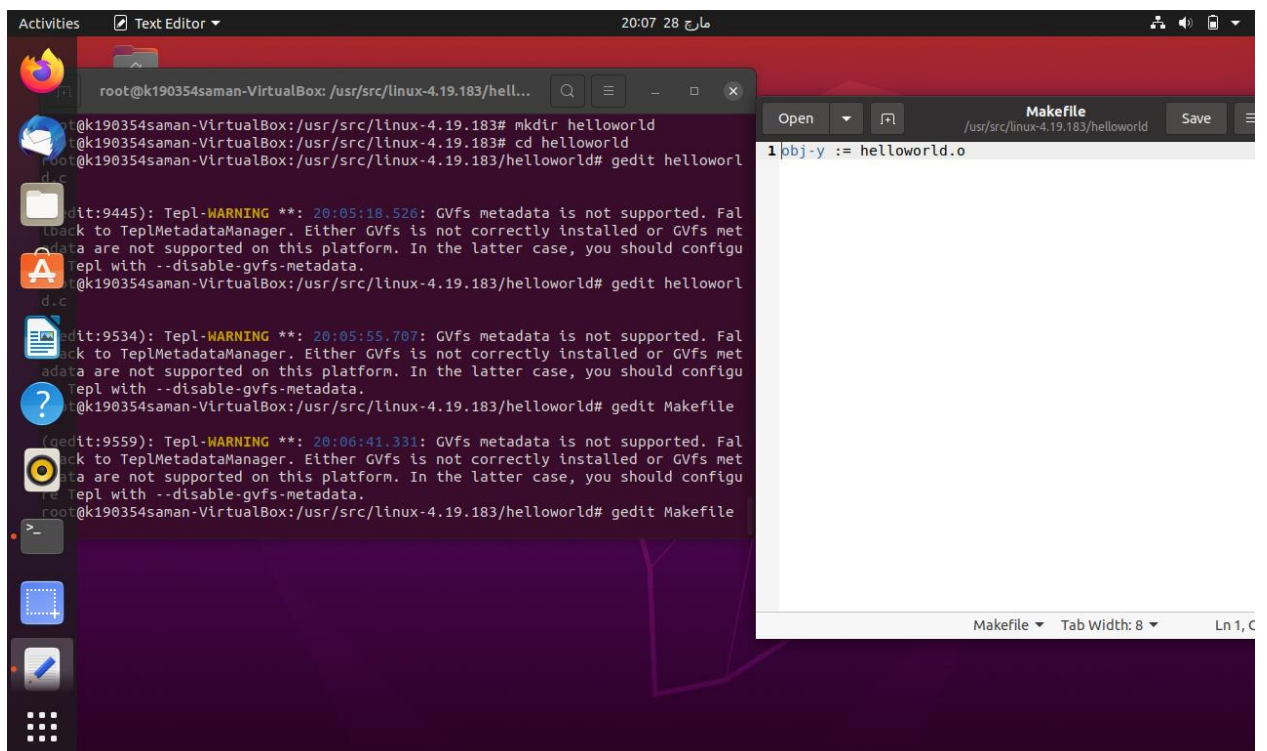
- Creating ahelloworld.c file and Makefile in helloworld directory:



A screenshot of a Linux desktop environment. The top panel shows the 'Activities' menu, a 'Text Editor' window, and the system clock at 20:05 on March 28. The 'Text Editor' window is titled 'helloworld.c' and shows the following C code:

```
1#include <linux/kernel.h>
2
3asmlinkage long sys_helloworld(void)
4{
5    printk("hello world\n");
6    return 0;
7}
```

The status bar at the bottom of the text editor indicates 'C', 'Tab Width: 8', 'Ln 1, Col 1', and 'INS'.



A screenshot of a Linux desktop environment. The top panel shows the 'Activities' menu, a 'Text Editor' window, and the system clock at 20:07 on March 28. The 'Text Editor' window is titled 'Makefile' and shows the following Makefile code:

```
1obj-y := helloworld.o
```

The status bar at the bottom of the text editor indicates 'Makefile', 'Tab Width: 8', and 'Ln 1, C'. In the background, a terminal window is open, showing the following commands and output:

```
root@k190354saman-VirtualBox: /usr/src/linux-4.19.183/hell...
root@k190354saman-VirtualBox: /usr/src/linux-4.19.183# mkdir helloworld
root@k190354saman-VirtualBox: /usr/src/linux-4.19.183# cd helloworld
root@k190354saman-VirtualBox: /usr/src/linux-4.19.183/helloworld# gedit helloworld.c
(edit:9445): Tepl-WARNING **: 20:05:18.526: GVfs metadata is not supported. Falling back to TeplMetadataManager. Either GVfs is not correctly installed or GVfs metadata are not supported on this platform. In the latter case, you should configure Tepl with --disable-gvfs-metadata.
root@k190354saman-VirtualBox: /usr/src/linux-4.19.183/helloworld# gedit helloworld.c
(edit:9534): Tepl-WARNING **: 20:05:55.707: GVfs metadata is not supported. Falling back to TeplMetadataManager. Either GVfs is not correctly installed or GVfs metadata are not supported on this platform. In the latter case, you should configure Tepl with --disable-gvfs-metadata.
root@k190354saman-VirtualBox: /usr/src/linux-4.19.183/helloworld# gedit Makefile
(edit:9559): Tepl-WARNING **: 20:06:41.331: GVfs metadata is not supported. Falling back to TeplMetadataManager. Either GVfs is not correctly installed or GVfs metadata are not supported on this platform. In the latter case, you should configure Tepl with --disable-gvfs-metadata.
```


- Adding helloworld/ to kernel's Makefile:

The screenshot shows a terminal window with the following commands and output:

```
root@k190354saman-VirtualBox: /usr/src/linux-4.19.183
root@k190354saman-VirtualBox: /usr/src/linux-4.19.183/helloworld# cd ..
root@k190354saman-VirtualBox: /usr/src/linux-4.19.183# gedit Makefile
```

The Makefile editor shows the following code:

```
982 endif
983 endif
984
985 PHONY += prepare0
986
987 ifeq ($(KBUILD_EXTMOD),)
988 core-y += kernel/ certs/ mm/ fs/ ipc/ security/ crypto/
989 block/ helloworld/
990
991 vmlinux-dirs := $(patsubst %/, %,$(filter %/, $(init-y) $(init-
992 m) \
993 $(core-y) $(core-m) $(drivers-y) $(drivers-
994 m) \
995 $(net-y) $(net-m) $(libs-y) $(libs-m) $(virt-
996 y)))
997
998 vmlinux-all-dirs := $(sort $(vmlinux-dirs) $(patsubst %/, %,-
999 $$(filter %/, \
1000 $(libs-y) $(virt-y)))
1001
1002 init-y := $(patsubst %/, %/built-in.a, $(init-y))
1003 core-y := $(patsubst %/, %/built-in.a, $(core-y))
1004 drivers-y := $(patsubst %/, %/built-in.a, $(drivers-y))
1005 net-y := $(patsubst %/, %/built-in.a, $(net-y))
1006 libs-y1 := $(patsubst %/, %/lib.a, $(libs-y))
1007 libs-y2 := $(patsubst %/, %/built-in.a, $(filter-
```

- Adding the new system call to the system call table:

The screenshot shows a terminal window with the following commands and output:

```
root@k190354saman-VirtualBox: /usr/src/linux-4.19.183/arch/x86/entry/syscalls
root@k190354saman-VirtualBox: /usr/src/linux-4.19.183/arch/x86/entry/syscalls# ls
Makefile syscall_32.tbl syscall_64.tbl syscallhdr.sh syscalltbl.sh
root@k190354saman-VirtualBox: /usr/src/linux-4.19.183/arch/x86/entry/syscalls# gedit syscall_64.tbl
```

The syscall_64.tbl editor shows the following code:

```
377 536 x32 rt_tgsigqueueinfo
378 537 x32 recvmmsg _x32_compat_sys_recvmmsg
379 538 x32 sendmmsg _x32_compat_sys_sendmmsg
380 539 x32 process_vm_readv
381 540 x32 process_vm_writev
382 541 x32 setsockopt _x32_compat_sys_setsockopt
383 542 x32 getsockopt _x32_compat_sys_getsockopt
384 543 x32 io_setup _x32_compat_sys_io_setup
385 544 x32 io_submit _x32_compat_sys_io_submit
386 545 x32 execveat _x32_compat_sys_execveat/-
ptregs
387 546 x32 preadv2
388 547 x32 pwritev2 _x32_compat_sys_pwritev2
389 548 64 helloworld sys_helloworld
```

- Adding new system call to the system call header file:

```

root@k190354saman-VirtualBox: /usr/src/linux-4.19.183/include/linux
root@k190354saman-VirtualBox: /usr/src/linux-4.19.183# cd ..
root@k190354saman-VirtualBox: /usr/src/linux-4.19.183# gedit Makefile
(gedit:9615): Tepl-WARNING **: 20:09:59.636: GVfs metadata is not supported. Fallback to TeplMetadataManager. Either GVfs is not correctly installed or GVfs metadata are not supported on this platform. In the latter case, you should configure Tepl with --disable-gvfs-metadata.
root@k190354saman-VirtualBox: /usr/src/linux-4.19.183/include/linux# gedit syscalls.h

```

The screenshot shows a terminal window with the following content:

```

1275         flags |= 0_LARGEFILE;
1276         return do_sys_open(AT_FDCWD, filename, flags, mode);
1277     }
1278
1279     extern long do_sys_truncate(const char __user *pathname, loff_t
length);
1280
1281     static inline long ksys_truncate(const char __user *pathname,
loff_t length)
1282     {
1283         return do_sys_truncate(pathname, length);
1284     }
1285
1286     static inline unsigned int ksys_personality(unsigned int
personality)
1287     {
1288         unsigned int old = current->personality;
1289
1290         if (personality != 0xffffffff)
1291             set_personality(personality);
1292
1293         return old;
1294     }
1295     asmlinkage long sys_helloworld(void);
1296 #endif

```

- Kernel configuration:

```

root@k190354saman-VirtualBox: /usr/src/linux-4.19.183
root@k190354saman-VirtualBox: /usr/src/linux-4.19.183# make menuconfig
HOSTCC scripts/basic/fixdep
UPD scripts/kconfig/.mconf.cfg
HOSTCC scripts/kconfig/mconf.o
YACC scripts/kconfig/zconf.tab.c
LEX scripts/kconfig/zconf.lex.c
HOSTCC scripts/kconfig/zconf.tab.o
HOSTCC scripts/kconfig/ldialog/checklist.o
HOSTCC scripts/kconfig/ldialog/inputbox.o
HOSTCC scripts/kconfig/ldialog/menubox.o
HOSTCC scripts/kconfig/ldialog/textbox.o
HOSTCC scripts/kconfig/ldialog/uttl.o
HOSTCC scripts/kconfig/ldialog/yesno.o
HOSTLD scripts/kconfig/mconf
scripts/kconfig/mconf Kconfig
#
# using defaults found in /boot/config-5.8.0-45-generic
#
/boot/config-5.8.0-45-generic:1525:warning: symbol value 'm' invalid for NF_TABLES_BRIDGE
/boot/config-5.8.0-45-generic:1610:warning: symbol value 'm' invalid for NET_DSA_TAG_BRCM
/boot/config-5.8.0-45-generic:1611:warning: symbol value 'm' invalid for NET_DSA_TAG_BRCM_PREPEND
/boot/config-5.8.0-45-generic:1613:warning: symbol value 'm' invalid for NET_DSA_TAG_DSA
/boot/config-5.8.0-45-generic:1614:warning: symbol value 'm' invalid for NET_DSA_TAG_EDSA
/boot/config-5.8.0-45-generic:1615:warning: symbol value 'm' invalid for NET_DSA_TAG_MTK
/boot/config-5.8.0-45-generic:1616:warning: symbol value 'm' invalid for NET_DSA_TAG_KSZ
/boot/config-5.8.0-45-generic:1618:warning: symbol value 'm' invalid for NET_DSA_TAG_QCA
/boot/config-5.8.0-45-generic:1619:warning: symbol value 'm' invalid for NET_DSA_TAG_LAN9303
/boot/config-5.8.0-45-generic:1621:warning: symbol value 'm' invalid for NET_DSA_TAG_TRAILER
/boot/config-5.8.0-45-generic:3989:warning: symbol value 'm' invalid for JOYSTICK_IFORCE_USB

```

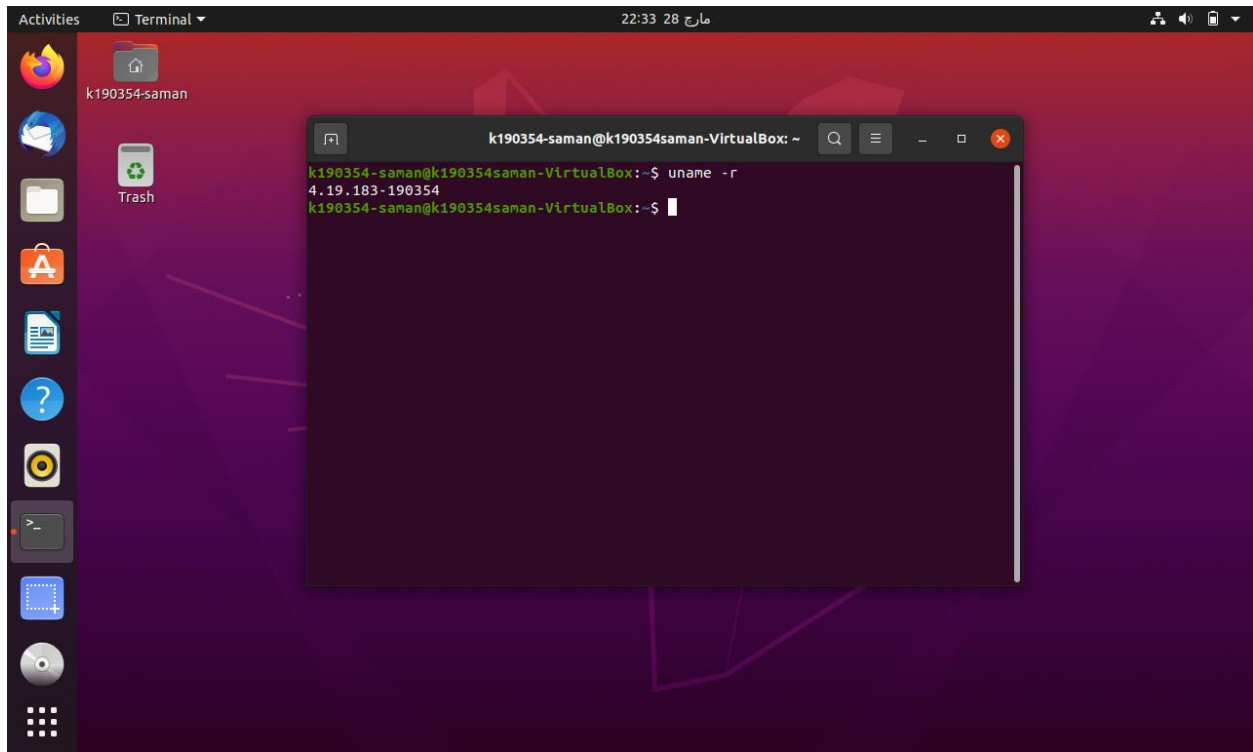
The screenshot shows a terminal window with the following content:

```

root@k190354saman-VirtualBox: /usr/src/linux-4.19.183
root@k190354saman-VirtualBox: /usr/src/linux-4.19.183# make menuconfig
HOSTCC scripts/basic/fixdep
UPD scripts/kconfig/.mconf.cfg
HOSTCC scripts/kconfig/mconf.o
YACC scripts/kconfig/zconf.tab.c
LEX scripts/kconfig/zconf.lex.c
HOSTCC scripts/kconfig/zconf.tab.o
HOSTCC scripts/kconfig/ldialog/checklist.o
HOSTCC scripts/kconfig/ldialog/inputbox.o
HOSTCC scripts/kconfig/ldialog/menubox.o
HOSTCC scripts/kconfig/ldialog/textbox.o
HOSTCC scripts/kconfig/ldialog/uttl.o
HOSTCC scripts/kconfig/ldialog/yesno.o
HOSTLD scripts/kconfig/mconf
scripts/kconfig/mconf Kconfig
#
# using defaults found in /boot/config-5.8.0-45-generic
#
/boot/config-5.8.0-45-generic:1525:warning: symbol value 'm' invalid for NF_TABLES_BRIDGE
/boot/config-5.8.0-45-generic:1610:warning: symbol value 'm' invalid for NET_DSA_TAG_BRCM
/boot/config-5.8.0-45-generic:1611:warning: symbol value 'm' invalid for NET_DSA_TAG_BRCM_PREPEND
/boot/config-5.8.0-45-generic:1613:warning: symbol value 'm' invalid for NET_DSA_TAG_DSA
/boot/config-5.8.0-45-generic:1614:warning: symbol value 'm' invalid for NET_DSA_TAG_EDSA
/boot/config-5.8.0-45-generic:1615:warning: symbol value 'm' invalid for NET_DSA_TAG_MTK
/boot/config-5.8.0-45-generic:1616:warning: symbol value 'm' invalid for NET_DSA_TAG_KSZ
/boot/config-5.8.0-45-generic:1618:warning: symbol value 'm' invalid for NET_DSA_TAG_QCA
/boot/config-5.8.0-45-generic:1619:warning: symbol value 'm' invalid for NET_DSA_TAG_LAN9303
/boot/config-5.8.0-45-generic:1621:warning: symbol value 'm' invalid for NET_DSA_TAG_TRAILER
/boot/config-5.8.0-45-generic:3989:warning: symbol value 'm' invalid for JOYSTICK_IFORCE_USB

```

- Updating Kernel:



- Testing System Call:

