Problem 1:

Lab policy Agreement:

ECEE Classroom Lab Policy Agreement

You will be emailed a copy of your responses. Please make sure to read and understand everything you agree to. If you violate any of the terms here, your lab access may be revoked. For any questions, email ecehelp@colorado.edu.

Your email address (**saka7049@colorado.edu**) was recorded when you submitted this form.

Student Commitment as a Lab User

I understand that *

☑ No food or drinks are allowed in the lab at the computer stations. Water bottles may be brought in but le~~ off of the computer stations. Food should be eaten before entering the lab~~

Problem 6:

Shell script:

```
if [ -f info.txt ]; then # If info.txt already exists, delete it
    rm info.txt
fi

echo -n "User Information : " >> info.txt | id >> info.txt

echo -e "\n" >> info.txt

echo -e "----------------------------------------------------------------------------------------------------------\n" >> info.txt


echo -n "Operating system type/brand : " >> info.txt | uname -o >> info.txt

echo -e "\n" >> info.txt

echo -e "----------------------------------------------------------------------------------------------------------\n" >> info.txt


echo -n "OS Distribution : " >> info.txt | lsb_release -d >> info.txt

echo -e "\n" >> info.txt

echo -e "----------------------------------------------------------------------------------------------------------\n" >> info.txt
```

```
echo -n "OS Version : " >> info.txt | cat /etc/*-release | grep "VERSION=" >>
info.txt

echo -e "\n" >> info.txt

echo -e "---------------------------------------------------------------------
------------------------------\n" >> info.txt


echo -n "Kernel Version : " >> info.txt | uname -r >> info.txt

echo -e "\n" >> info.txt

echo -e "---------------------------------------------------------------------
------------------------------\n" >> info.txt


echo -n "Kernel gcc version build : " >> info.txt | gcc --version | grep gcc >>
info.txt

echo -e "\n" >> info.txt

echo -e "---------------------------------------------------------------------
------------------------------\n" >> info.txt


echo -n "Kernel Build Time : " >> info.txt | uname -v >> info.txt

echo -e "\n" >> info.txt

echo -e "---------------------------------------------------------------------
------------------------------\n" >> info.txt


echo "System Architecture Information : " >> info.txt

lscpu  >> info.txt

echo -e "\n" >> info.txt

echo -e "---------------------------------------------------------------------
------------------------------\n" >> info.txt


echo "Information on File System Memory : " >> info.txt

df -h  >> info.txt

echo -e "\n" >> info.txt

echo -e "---------------------------------------------------------------------
------------------------------\n" >> info.txt
```

Shell script output:

User Information : uid=1000(sanjuprakash) gid=1000(sanjuprakash)
groups=1000(sanjuprakash),4(adm),24(cdrom),27(sudo),30(dip),46(plugdev),116(lpadmin),
126(sambashare)

Operating system type/brand : GNU/Linux

OS Distribution : Description: Ubuntu 18.04.1 LTS

OS Version : VERSION="18.04.1 LTS (Bionic Beaver)"

Kernel Version : 4.15.0-43-generic

Kernel gcc version build : gcc (Ubuntu 7.3.0-27ubuntu1~18.04) 7.3.0

Kernel Build Time : #46-Ubuntu SMP Thu Dec 6 14:45:28 UTC 2018

System Architecture Information :

Architecture: x86_64

CPU op-mode(s):   32-bit, 64-bit

Byte Order: Little Endian

```
CPU(s):                4

On-line CPU(s) list: 0-3

Thread(s) per core:  2

Core(s) per socket:  2

Socket(s):           1

NUMA node(s):        1

Vendor ID:           GenuineIntel

CPU family:          6

Model:               78

Model name:          Intel(R) Core(TM) i7-6600U CPU @ 2.60GHz

Stepping:            3

CPU MHz:             1303.162

CPU max MHz:         3400.0000

CPU min MHz:         400.0000

BogoMIPS:            5616.00

Virtualization:      VT-x

L1d cache:           32K

L1i cache:           32K

L2 cache:            256K

L3 cache:            4096K

NUMA node0 CPU(s):   0-3
```

Flags: fpu vme de pse tsc msr pae mce cx8 apic sep mtrr pge mca cmov
pat pse36 clflush dts acpi mmx fxsr sse sse2 ss ht tm pbe syscall nx pdpe1gb rdtscp
lm constant_tsc art arch_perfmon pebs bts rep_good nopl xtopology nonstop_tsc cpuid
aperfmperf tsc_known_freq pni pclmulqdq dtes64 monitor ds_cpl vmx smx est tm2 ssse3
sdbg fma cx16 xtpr pdcm pcid sse4_1 sse4_2 x2apic movbe popcnt tsc_deadline_timer aes
xsave avx f16c rdrand lahf_lm abm 3dnowprefetch cpuid_fault epb invpcid_single pti
ssbd ibrs ibpb stibp tpr_shadow vnmi flexpriority ept vpid fsgsbase tsc_adjust bmi1
hle avx2 smep bmi2 erms invpcid rtm mpx rdseed adx smap clflushopt intel_pt xsaveopt
xsavec xgetbv1 xsaves dtherm ida arat pln pts hwp hwp_notify hwp_act_window hwp_epp
flush_l1d

Information on File System Memory :

Filesystem   Size Used Avail Use% Mounted on

```
udev             7.8G     0  7.8G    0% /dev
tmpfs            1.6G  2.1M  1.6G    1% /run
/dev/nvme0n1p5    19G  7.2G   11G   42% /
tmpfs            7.8G   58M  7.8G    1% /dev/shm
tmpfs            5.0M  4.0K  5.0M    1% /run/lock
tmpfs            7.8G     0  7.8G    0% /sys/fs/cgroup
/dev/loop1        87M   87M     0  100% /snap/core/4917
/dev/loop0       141M  141M     0  100% /snap/gnome-3-26-1604/70
/dev/loop2       3.8M  3.8M     0  100% /snap/gnome-system-monitor/51
/dev/loop3        15M   15M     0  100% /snap/gnome-logs/37
/dev/loop5       2.4M  2.4M     0  100% /snap/gnome-calculator/180
/dev/loop4        35M   35M     0  100% /snap/gtk-common-themes/319
/dev/loop6        30M   30M     0  100% /snap/sublime-text/44
/dev/loop7        15M   15M     0  100% /snap/gnome-logs/45
/dev/loop8        13M   13M     0  100% /snap/gnome-characters/139
/dev/loop9        90M   90M     0  100% /snap/core/6130
/dev/loop10      2.3M  2.3M     0  100% /snap/gnome-calculator/260
/dev/loop12       30M   30M     0  100% /snap/sublime-text/38
/dev/loop11       13M   13M     0  100% /snap/gnome-characters/103
/dev/loop13       35M   35M     0  100% /snap/gtk-common-themes/818
/dev/loop14      141M  141M     0  100% /snap/gnome-3-26-1604/74
/dev/loop15      3.8M  3.8M     0  100% /snap/gnome-system-monitor/57
/dev/nvme0n1p1   495M   31M  465M    7% /boot/efi
/dev/nvme0n1p6   105G   27G   73G   27% /home
tmpfs            1.6G   16K  1.6G    1% /run/user/121
tmpfs            1.6G   44K  1.6G    1% /run/user/1000
/dev/nvme0n1p3   351G  183G  169G   53% /media/sanjuprakash/OS


--------------------------------------------------------------------------------
---------------------
```

Problem 7:

Output of static library:

```
sanjuprakash@sanjuprakash:~/Desktop/APES1/MELP/Chapter02/library/hello-arm$ ./hello-arm-static
Hello from ARM
add_ints
4 + 5 = 9
multiply_ints
4 * 5 = 20
```

Output of shared library:

```
sanjuprakash@sanjuprakash:~/Desktop/APES1/MELP/Chapter02/library/hello-arm$ ./hello-arm-shared
./hello-arm-shared: error while loading shared libraries: libtest.so: cannot open shared object file: No such file or directory
sanjuprakash@sanjuprakash:~/Desktop/APES1/MELP/Chapter02/library/hello-arm$ LD_LIBRARY_PATH=../shared ./hello-arm-shared
Hello from ARM
add_ints
4 + 5 = 9
multiply_ints
4 * 5 = 20
```

ls -l hello-arm-s*

```
sanjuprakash@sanjuprakash:~/Desktop/APES1/MELP/Chapter02/library/hello-arm$ ls -l hello-arm-s*
-rwxr-xr-x 1 sanjuprakash sanjuprakash  8416 Jan 23 22:02 hello-arm-shared
-rwxr-xr-x 1 sanjuprakash sanjuprakash 11232 Jan 23 22:02 hello-arm-static
```

readelf -a hello-arm-shared | grep "Shared library"

```
sanjuprakash@sanjuprakash:~/Desktop/APES1/MELP/Chapter02/library/hello-arm$ readelf -a  hello-arm-shared | grep "Shared library"
 0x0000000000000001 (NEEDED)                Shared library: [libtest.so]
 0x0000000000000001 (NEEDED)                Shared library: [libc.so.6]
```

readelf -a hello-arm-shared | grep "program interpreter"

```
sanjuprakash@sanjuprakash:~/Desktop/APES1/MELP/Chapter02/library/hello-arm$ readelf -a  hello-arm-shared | grep "program interpreter"
      [Requesting program interpreter: /lib64/ld-linux-x86-64.so.2]
```

Problem 8:

Toolchain for BeagleBone:

arm-cortex_a8-linux-gnueabinf-gcc --version

```
sanjuprakash@sanjuprakash:~/Desktop/APES1/Chapter02-qemu/Chapter02/library/hello-arm$ arm-cortex_a8-linux-gnueabihf-gcc --version
arm-cortex_a8-linux-gnueabihf-gcc (crosstool-NG 1.23.0.593-daa0752) 8.2.0
Copyright (C) 2018 Free Software Foundation, Inc.
This is free software; see the source for copying conditions.  There is NO
warranty; not even for MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.
```

arm-cortex_a8-linux-gnueabinf-gcc -print-sysroot

```
sanjuprakash@sanjuprakash:~$ arm-cortex_a8-linux-gnueabihf-gcc -print-sysroot
/home/sanjuprakash/x-tools/arm-cortex_a8-linux-gnueabihf/arm-cortex_a8-linux-gnueabihf/sysroot
```

ls -l hello-arm-s*

```
sanjuprakash@sanjuprakash:~/Desktop/APES1/Chapter02-arm/Chapter02/library/hello-arm$ ls -l hello-arm-s*
-rwxr-xr-x 1 sanjuprakash sanjuprakash 12100 Jan 24 11:19 hello-arm-shared
-rwxr-xr-x 1 sanjuprakash sanjuprakash 14692 Jan 24 11:19 hello-arm-static
```

arm-cortex_a8-linux-gnueabinf-readelf -a hello-arm-shared | grep "Shared library"

```
sanjuprakash@sanjuprakash:~/Desktop/APES1/Chapter02-arm/Chapter02/library/hello-arm$ arm-cortex_a8-linux-gnueabihf-readelf -a hello-a
rm-shared | grep "Shared library"
 0x00000001 (NEEDED)                Shared library: [libtest.so]
 0x00000001 (NEEDED)                Shared library: [libc.so.6]
```

arm-cortex_a8-linux-gnueabinf-readelf -a hello-arm-shared | grep "program interpreter"

```
sanjuprakash@sanjuprakash:~/Desktop/APES1/Chapter02-arm/Chapter02/library/hello-arm$ arm-cortex_a8-linux-gnueabihf-readelf -a hello-a
rm-shared | grep "program interpreter"
      [Requesting program interpreter: /lib/ld-linux-armhf.so.3]
```

Toolchain for QEMU:

arm-unknown-linux-gnueabi-gcc --version

```
sanjuprakash@sanjuprakash:~/Desktop/APES1/crosstool-ng$ arm-unknown-linux-gnueabi-gcc --version
arm-unknown-linux-gnueabi-gcc (crosstool-NG 1.23.0.593-daa0752) 8.2.0
Copyright (C) 2018 Free Software Foundation, Inc.
This is free software; see the source for copying conditions.  There is NO
warranty; not even for MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.
```

arm-unknown-linux-gnueabi-gcc -print-sysroot

```
sanjuprakash@sanjuprakash:~/Desktop/APES1/crosstool-ng$ arm-unknown-linux-gnueabi-gcc -print-sysroot
/home/sanjuprakash/x-tools/arm-unknown-linux-gnueabi/arm-unknown-linux-gnueabi/sysroot
```

ls -l hello-arm-s*

```
sanjuprakash@sanjuprakash:~/Desktop/APES1/Chapter02-qemu/Chapter02/library/hello-arm$ ls -l hello-arm-s*
-rwxr-xr-x 1 sanjuprakash sanjuprakash 12044 Jan 24 15:34 hello-arm-shared
-rwxr-xr-x 1 sanjuprakash sanjuprakash 14644 Jan 24 15:34 hello-arm-static
```

arm-unknown-linux-gnueabi-readelf -a hello-arm-shared | grep "Shared library"

```
sanjuprakash@sanjuprakash:~/Desktop/APES1/Chapter02-qemu/Chapter02/library/hello-arm$ arm-unknown-linux-gnueabi-readelf -a hello-arm-
shared | grep "Shared library"
 0x00000001 (NEEDED)                     Shared library: [libtest.so]
 0x00000001 (NEEDED)                     Shared library: [libc.so.6]
```

arm-unknown-linux-gnueabi-readelf -a hello-arm-shared | grep "program interpreter"

```
sanjuprakash@sanjuprakash:~/Desktop/APES1/Chapter02-qemu/Chapter02/library/hello-arm$ arm-unknown-linux-gnueabi-readelf -a hello-arm-
shared | grep "program interpreter"
      [Requesting program interpreter: /lib/ld-linux.so.3]
```