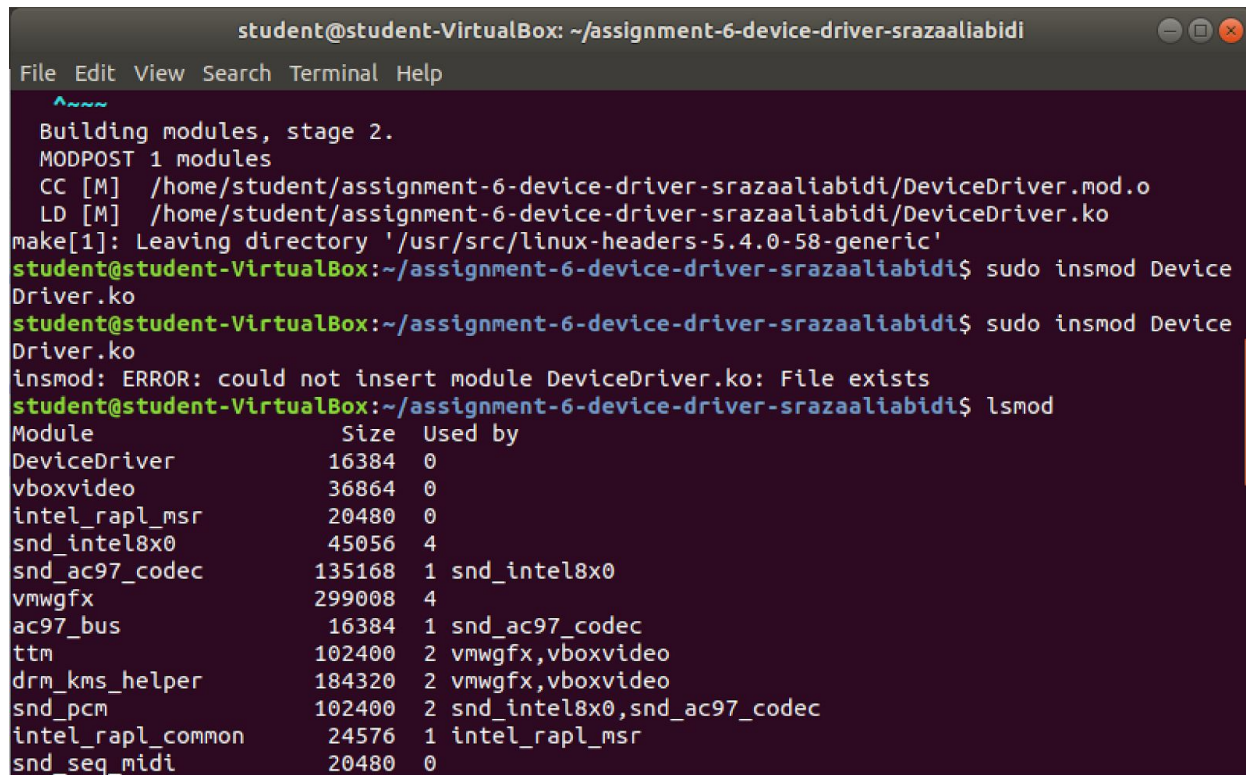


```
/******  
* Class: CSC-415-0# Fall 2020  
* Name: Raza Ali  
* Student ID: 917648503  
* GitHub ID: srazaaliabidi  
* Project: Assignment 6 – Device Driver  
*  
*  
*  
*****/
```

For this project we were assigned firsthand to learn the process of device drivers and how they work, while also learning how to link them directly to a user program so that we may learn how this directly writes data to a driver, reads and can output certain characteristics that we may choose to show. Within this project I had decided to go with what was asked which is a calculator that uses a device driver to pull information and return the appropriate correct calculations. For this assignment I did run into some trouble in terms of understanding how to appropriately get the device driver to work via the shell, as well as understanding that there is a second make file needed in a subdirectory in order for our program to compile. I kept running into the issue where I was trying to do a make run on the user application makefile, but kept getting compilation errors as I wasn't accessing it as root, but in the end it did end up working appropriately. All in all once I understood the basic concepts of getting the device driver created it was not as hard as I thought it would be, and this assignment turned out to go better than I initially expected it to. The commands that I used in order to check and make it work in order include: make, sudo insmod DeviceDriver.ko, then I did a lsmod to check to see if the drivers are initialized which can be seen below, then I entered into the subdirectory cd User \Application\, followed by a sudo make run to get the results seen below.

Screenshot showing the DeviceDriver is initialized upon running `sudo insmod DeviceDriver.ko`



```
student@student-VirtualBox: ~/assignment-6-device-driver-srazaaliabidi
File Edit View Search Terminal Help

^~^~^~
Building modules, stage 2.
MODPOST 1 modules
CC [M] /home/student/assignment-6-device-driver-srazaaliabidi/DeviceDriver.mod.o
LD [M] /home/student/assignment-6-device-driver-srazaaliabidi/DeviceDriver.ko
make[1]: Leaving directory '/usr/src/linux-headers-5.4.0-58-generic'
student@student-VirtualBox:~/assignment-6-device-driver-srazaaliabidi$ sudo insmod DeviceDriver.ko
student@student-VirtualBox:~/assignment-6-device-driver-srazaaliabidi$ sudo insmod DeviceDriver.ko
insmod: ERROR: could not insert module DeviceDriver.ko: File exists
student@student-VirtualBox:~/assignment-6-device-driver-srazaaliabidi$ lsmod
Module                Size  Used by
DeviceDriver           16384  0
vboxvideo              36864  0
intel_rapl_msr         20480  0
snd_intel8x0           45056  4
snd_ac97_codec         135168  1 snd_intel8x0
vmwgfx                 299008  4
ac97_bus               16384  1 snd_ac97_codec
ttm                    102400  2 vmwgfx,vboxvideo
drm_kms_helper         184320  2 vmwgfx,vboxvideo
snd_pcm                102400  2 snd_intel8x0,snd_ac97_codec
intel_rapl_common      24576  1 intel_rapl_msr
snd_seq_midi           20480  0
```

In order to get the assignment to run first start by running a make to initialize our DeviceDriver as shown above. After going through this step we can cd into our User Application Subdirectory where we're able to reach our calculator. From here it becomes self explanatory and included below are screenshots of the running calculator which is writing the value to the driver then reading it.

```
student@student-VirtualBox: ~/assignment-6-device-driver-srazaaliabidi/User Application
File Edit View Search Terminal Help
Building modules, stage 2.
MODPOST 1 modules
CC [M] /home/student/assignment-6-device-driver-srazaaliabidi/DeviceDriver.mod.o
LD [M] /home/student/assignment-6-device-driver-srazaaliabidi/DeviceDriver.ko
make[1]: Leaving directory '/usr/src/linux-headers-5.4.0-58-generic'
student@student-VirtualBox:~/assignment-6-device-driver-srazaaliabidi$ cd User\ Application/
student@student-VirtualBox:~/assignment-6-device-driver-srazaaliabidi/User Application$ sudo make run
./6
-----

Opening Driver...
Operation to preform:

    1. Add
    2. Subtract
    3. Multiply
    4. Divide

1
Enter first value: 1
Enter second value: 2
writing value to driver...
Reading value from driver...
Value is: 3
Closing our driver....
student@student-VirtualBox:~/assignment-6-device-driver-srazaaliabidi/User Application$
```

Another example of it working:

```
student@student-VirtualBox: ~/assignment-6-device-driver-srazaaliabidi/User Application
File Edit View Search Terminal Help
writing value to driver...
Reading value from driver...
Value is: 3
Closing our driver....
student@student-VirtualBox:~/assignment-6-device-driver-srazaaliabidi/User Application$ sudo make run
gcc -c -o Application.o Application.c -g -I.
gcc -o 6 Application.o -g -I.
./6
-----

Opening Driver...
Operation to preform:

    1. Add
    2. Subtract
    3. Multiply
    4. Divide

3
Enter first value: 2
Enter second value: 3
writing value to driver...
Reading value from driver...
Value is: 6
Closing our driver....
student@student-VirtualBox:~/assignment-6-device-driver-srazaaliabidi/User Application$
```

Also included below is a screenshot of running the `dmesg --kernel` command to check to see

whether our DeviceDriver is properly allocating the operand space and each variable as well as telling us if it is working (pictured in the bottom 4 lines of the shell):

```
student@student-VirtualBox: ~/assignment-6-device-driver-srazaaliabidi/User Application
File Edit View Search Terminal Help
[ 12.900939] [drm:vmw_host_log [vmwgfx]] *ERROR* Failed to send host log message.
[ 12.903226] [drm:vmw_host_log [vmwgfx]] *ERROR* Failed to send host log message.
[ 12.906770] fbcon: svgadrmfb (fb0) is primary device
[ 12.908471] Console: switching to colour frame buffer device 100x37
[ 12.909046] [drm] Initialized vmwgfx 2.15.0 20180704 for 0000:00:02.0 on minor 0
[ 14.547887] snd_intel8x0 0000:00:05.0: white list rate for 1028:0177 is 48000
[ 23.036383] e1000: enp0s3 NIC Link is Up 1000 Mbps Full Duplex, Flow Control: RX
[ 23.036711] IPv6: ADDRCONF(NETDEV_CHANGE): enp0s3: link becomes ready
[ 42.955424] 20:36:00.997864 main      VBoxService 6.1.2 r135662 (verbosity: 0) linux.amd64 (Jan 13 2020 12
:06:55) release log
                20:36:00.997867 main      Log opened 2020-12-16T20:36:00.997815000Z
[ 42.955461] 20:36:00.997930 main      OS Product: Linux
[ 42.955485] 20:36:00.997955 main      OS Release: 5.4.0-58-generic
[ 42.955519] 20:36:00.997979 main      OS Version: #64~18.04.1-Ubuntu SMP Wed Dec 9 17:11:11 UTC 2020
[ 42.955552] 20:36:00.998012 main      Executable: /opt/VBoxGuestAdditions-6.1.2/sbin/VBoxService
                20:36:00.998013 main      Process ID: 1309
                20:36:00.998014 main      Package type: LINUX_64BITS_GENERIC
[ 42.957651] 20:36:01.000116 main      6.1.2 r135662 started. Verbose level = 0
[ 42.959268] 20:36:01.001729 main      vbglR3GuestCtrlDetectPeekGetCancelSupport: Supported (#1)
[ 73.641852] rfkill: input handler disabled
[ 378.364525] MAJOR = 240 MINOR = 0
[ 378.365457] Device Driver Insert... DONE
[ 686.517914] op = 3
[ 690.600948] val1 = 6
[ 690.600949] val2 = 4
student@student-VirtualBox:~/assignment-6-device-driver-srazaaliabidi/User Application$
```