

In this assignment, you shall develop a very simple Linux kernel module that runs on your virtual machine.

Please consult the freely available O'Reilly book “Linux Device Drivers, 3rd Edition”

(<https://lwn.net/Kernel/LDD3/>), in particular p.16, as well as your text book p.96 to get you started. Note that even though the book is written for kernel version 2.6, most mechanisms are applicable with minor or no changes. The relevant function is copied below as a starting point.

```
#include <linux/init.h>
#include <linux/module.h>
MODULE_LICENSE("Dual BSD/GPL");
static int hello_init(void)
{
    printk(KERN_ALERT "Hello, world\n");
    return 0;
}
static void hello_exit(void)
{
    printk(KERN_ALERT "Goodbye, cruel world\n");
}
module_init(hello_init);
module_exit(hello_exit);
```

The `hello_init()` function is invoked when you insert your module (using the `insmod` shell command), whereas the `hello_exit()` is called when you unload your module (using the `rmmmod` shell command).

Modify this module such that:

- 1) The init function prints the tick time in milliseconds (as we define it in lecture 2) after the hello message,
- 2) The exit function prints a goodbye message and the time between the insertion and removal of the module i.e. between init and exit functions) using two different methods:
 - a. Using the difference in the value of jiffies from inserting the module to removing the module (HINT Hint: Search for “jiffies” and “HZ” in the O'Reilly book)
 - b. Using the time difference obtained by reading the timer (Hint: use `ktime_get_boottime(void)`, more documentation may be found at <https://www.kernel.org/doc/html/latest/core-api/timekeeping.html>).

Use the `dmesg` shell command to view messages printed by `printk()`.

You may use the Makefile provided in the O'Reilly book, but you may need to install the kernel headers prior to using it if not already installed:

```
sudo apt-get install linux-headers-$(uname -r)
```