

# Practice linux kernal module

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Version 1.0

## 1 Command in terminal


See the command usage and information

```
$ man {command}
```

Example:

```
$ man insmod
```

Result



```
danny@dannyPC: ~/project/kernel
INSMOD(8)                                insmod                                INSMOD(8)

NAME
    insmod - Simple program to insert a module into the Linux Kernel

SYNOPSIS
    insmod [filename] [module options...]

DESCRIPTION
    insmod is a trivial program to insert a module into the kernel. Most
    users will want to use modprobe(8) instead, which is more clever and
    can handle module dependencies.

    Only the most general of error messages are reported: as the work of
    trying to link the module is now done inside the kernel, the dmesg
    usually gives more information about errors.

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SEE ALSO
    modprobe(8), rmmmod(8), lsmod(8), modinfo(8) depmod(8)
    Manual page insmod(8) line 1 (press h for help or q to quit)
```

Insert a kernal module

```
$ sudo insmod {module name (*.ko)}
```

Show a kernal module info

```
$ sudo modinfo {module name (*.ko)}
```

### Print or control the kernel ring buffer

```
$ sudo dmesg
```

### Simple program to remove a module from the Linux Kernel

```
$ sudo rmmod {module name}
```

### Add and remove modules from the Linux Kernel

Loads the module only in /lib/modules/`uname -r` modprobe depends on depmod tool to calculate dependancies

```
$ sudo modprobe {module name}
$ echo the dependancies
$ vi /lib/module/`uname -r`/modules.dep
```

## 2 Hello world

### Example code below

```
#include <linux/kernel.h>
#include <linux/module.h>

MODULE_LICENSE("GPL");
static int test_hello_init (void) {
    printk(KERN_INFO"%s: In init \n", __func__);
    return 0;
}

static void test_hello_exit (void) {
    printk(KERN_INFO"%s: In exit \n", __func__);
}

module_init( test_hello_init );
module_exit( test_hello_exit );
```

### Include header and define the LICENSE(option)

```
#include <linux/kernel.h>
#include <linux/module.h>

MODULE_LICENSE("GPL");
```

### When insert module, it will call the initial function

```
static int test_hello_init (void) {
    printk(KERN_INFO"%s: In init \n", __func__);
    return 0;
}

module_init( test_hello_init );
```

### When rmmod the kernel module, it will call the exit function

```
static void test_hello_exit (void) {
    printk(KERN_INFO"%s: In exit \n", __func__);
}
```

```

}

module_exit( test_hello_exit );

```

## Build steps

1. Write the Makefile

```

obj-m := hello-world.o

all :
    make -C /lib/modules/$(uname -r)/build M=$(PWD) modules

clean:
    make -C /lib/modules/$(uname -r)/build M=$(PWD) clean

```

2. Build

```
$ make all
```

## 3 Internal module init

Example code below

```

#include <linux/kernel.h>
#include <linux/module.h>

MODULE_LICENSE("GPL");

/*
 * Kernel module default initial function name
 */
int init_module(void) {
    printk(KERN_INFO"%s: In init\n", __func__);
    return 0;
}

/*
 * Kernel module default exit function name
 */
void cleanup_module(void) {
    printk(KERN_INFO"%s: In exit\n", __func__);
}

MODULE_AUTHOR("Danny Deng");
MODULE_DESCRIPTION("Internal module example");

```

- First In my case the *module\_init* define in this file  
"/usr/src/linux-hwe-5.11-headers-5.11.0-41/include/linux/module.h"
- Second, the macro *module\_init* will expand the function with "alias" to let function call the same thing with different name.

```

/* Each module must use one module_init(). */
#define module_init(initfn) \
    static inline initcall_t __maybe_unused __inittest(void) \
    { return initfn; } \
    int init_module(void) __copy(initfn) __attribute__((alias(#initfn)));

/* This is only required if you want to be unloadable. */
#define module_exit(exitfn) \
    static inline exitcall_t __maybe_unused __exittest(void) \
    { return exitfn; } \
    void cleanup_module(void) __copy(exitfn) __attribute__((alias(#\
    exitfn)));

#endif

```

## 4 Passing parameters to linux kernel module

Using *module\_param* function to declare parameters

**Example code below**

```

#include <linux/kernel.h>
#include <linux/module.h>

MODULE_LICENSE("GPL");

char *name = "Danny";
int count = 0;
module_param(name, charp, S_IRUGO);
module_param(count, int, S_IRUGO);

static int test_arguments_init(void) {
    printk(KERN_INFO"%s: In init\n", __func__);
    printk(KERN_INFO"%s: name: %s\n", __func__, name);
    printk(KERN_INFO"%s: pass count: %d\n", __func__, count);

    return 0;
}

static void test_exit(void) {
    printk(KERN_INFO"%s: In exit: \n", __func__);
}

module_init(test_arguments_init);
module_exit(test_exit);

MODULE_AUTHOR("Danny Deng");
MODULE_DESCRIPTION("Argument parsing example");

```

**Each parameters can declare different permission**

```
usr > src > linux-hwe-5.11-headers-5.11.0-41 > include > linux > C stat.h > ...
1  /* SPDX-License-Identifier: GPL-2.0 */
2  ~ #ifndef _LINUX_STAT_H
3  #define _LINUX_STAT_H
4
5
6  ~ #include <asm/stat.h>
7  #include <uapi/linux/stat.h>
8
9  #define S_IRWXUGO  (S_IRWXU|S_IRWXG|S_IRWXO)
10 #define S_IALLUGO  (S_ISUID|S_ISGID|S_ISVTX|S_IRWXUGO)
11 #define S_IRUGO    (S_IRUSR|S_IRGRP|S_IROTH)
12 #define S_IWUGO    (S_IWUSR|S_IWGRP|S_IWOTH)
13 #define S_IXUGO    (S_IXUSR|S_IXGRP|S_IXOTH)
14
```

The macro value define below

```
#define S_IRWXU 00700
#define S_IRUSR 00400
#define S_IWUSR 00200
#define S_IXUSR 00100

#define S_IRWXG 00070
#define S_IRGRP 00040
#define S_IWGRP 00020
#define S_IXGRP 00010

#define S_IRWXO 00007
#define S_IROTH 00004
#define S_IWOTH 00002
#define S_IXOTH 00001
```

$S_I + R/W/X + USR/GRP/OTH$

- R: Read
- W: Write
- X: Execute
- USR: User
- GRP: Group
- OTH: Other

**Insert the kernel module, and feed the parameter**

```
$ sudo insmod passing_simple_count.ko count=10 name=Danny
```

**Remove the kernel module**

```
$ sudo rmmod passing_simple_count
```

## Show the result

```
$ dmesg
```

```
danny@dannyPC:~/project/kernel/03_passing_parameter$ sudo insmod passing_simple_count.ko count=10 name=Danny
danny@dannyPC:~/project/kernel/03_passing_parameter$ sudo rmmod passing_simple_count
danny@dannyPC:~/project/kernel/03_passing_parameter$ dmesg
[ 3654.716861] test_arguments_init: In init
[ 3654.716864] test_arguments_init: name: Danny
[ 3654.716865] test_arguments_init: pass count: 10
[ 3659.162359] test_exit: In exit:
danny@dannyPC:~/project/kernel/03_passing_parameter$
```

## 5 Module stacking

**Module 1 code below, declare the `my_add` function**

Using `EXPORT_SYMBOL` to export symbol

```
#include <linux/kernel.h>
#include <linux/module.h>

MODULE_LICENSE("GPL");

int my_add(int a, int b) {
    return a + b;
}
EXPORT_SYMBOL(my_add);

static int test_init (void) {
    printk(KERN_INFO"%s: In init by module1\n", __func__);

    return 0;
}

static void test_exit (void) {
    printk(KERN_INFO"%s: In exit by module1: \n", __func__);
}

module_init( test_init );
module_exit(test_exit);

MODULE_AUTHOR("Danny Deng");
MODULE_DESCRIPTION("Argument parsing example");
```

**Module 2 code below, call the `my_add` function**

```
#include <linux/kernel.h>
#include <linux/module.h>

MODULE_LICENSE("GPL");

/* Define in module1.c and already EXPORT_SYMBOL */
extern int my_add(int a, int b);

static int test_init (void) {
    printk(KERN_INFO"%s: In init by module2\n", __func__);
    printk(KERN_INFO"my_add(1, 2): %d\n", my_add(1, 2));
}
```

```

    return 0;
}

static void test_exit(void) {
    printk(KERN_INFO"%s: In exit by module2: \n", __func__);
}

module_init( test_init );
module_exit(test_exit);

MODULE_AUTHOR("Danny Deng");
MODULE_DESCRIPTION("Argument parsing example");

```

## Result

```

danny@dannyPC:~/project/kernel$ sudo insmod 05_module_stacking/module1.ko
danny@dannyPC:~/project/kernel$ sudo insmod 05_module_stacking/module2.ko
danny@dannyPC:~/project/kernel$ sudo dmesg
[ 2373.651699] module2: Unknown symbol my_add (err -2)
[ 2378.755736] test_init: In init by module1
[ 2381.217561] test_init: In init by module2
[ 2381.217564] my_add(1, 2): 3
danny@dannyPC:~/project/kernel$

```

## 6 Module licence

### 6.1 Tainted kernel document

Linux bash to determine whether tainted kernel

- [tainted kernel check script](#)
- [tainted kernels document](#)

Use the run time command to determine whether kernel tainted

```
$ cat /proc/sys/kernel/tainted
```

### 6.2 Result

```

[21263.515393] module_licence: module verification failed: signature and/or required key missing - tainting kernel
[21263.516028] test_init: In init by module1
danny@dannyPC:~/project/kernel$

```