Lab 11

1- Demonstrate the compilation and execution process of the following program. Insert break point while calculating c, and print the value of c for each iteration (Attach screenshots).

```
(gdb) run 4 5
The program being debugged has been started already.
Start it from the beginning? (y or n) y
Starting program: /home/Zuhaib/Desktop/CEW Project/test 4 5
[Thread debugging using libthread_db enabled]
Using host libthread_db library "/lib/x86_64-linux-gnu/libthread_db.so.1".

Breakpoint 1, main (argc=3, argv=0x7fffffffdfa8) at array_operation.c:11
11              c = a*i;
(gdb)
(gdb)
(gdb) s
12              printf("%d * %d = %d\n", a, i, c);
(gdb) n
4 * 1 = 4
9           for(int i=1;i<=b;i++)
(gdb)

Breakpoint 1, main (argc=3, argv=0x7fffffffdfa8) at array_operation.c:11
11              c = a*i;
(gdb)
12              printf("%d * %d = %d\n", a, i, c);
(gdb) n
4 * 2 = 8
9           for(int i=1;i<=b;i++)
(gdb)

Breakpoint 1, main (argc=3, argv=0x7fffffffdfa8) at array_operation.c:11
11              c = a*i;
(gdb) n
12              printf("%d * %d = %d\n", a, i, c);
(gdb) n
4 * 3 = 12
9           for(int i=1;i<=b;i++)
(gdb)

Breakpoint 1, main (argc=3, argv=0x7fffffffdfa8) at array_operation.c:11
11              c = a*i;
(gdb) n
12              printf("%d * %d = %d\n", a, i, c);
(gdb) n
4 * 4 = 16
9           for(int i=1;i<=b;i++)
(gdb)
```

```
4 * 4 = 16
9           for(int i=1;i<=b;i++)
(gdb)

Breakpoint 1, main (argc=3, argv=0x7fffffffdfa8) at array_operation.c:11
11              c = a*i;
(gdb)
12              printf("%d * %d = %d\n", a, i, c);
(gdb) n
4 * 5 = 20
9           for(int i=1;i<=b;i++)
(gdb)
14          return 0;
(gdb)
15      }
(gdb)
__libc_start_call_main (main=main@entry=0x555555555169 <main>, argc=argc@entry=3, argv=argv@entry=0x7fffffffdfa8) at ../sysdeps/nptl/libc_start_call_main.h:74
74      ../sysdeps/nptl/libc_start_call_main.h: No such file or directory.
(gdb)
[Inferior 1 (process 4461) exited normally]
(gdb)
The program is not being run.
(gdb)
```

2- Write a C program that initializes an array and performs some operations on its elements. Save the program in a file named array_operations.c. Compile the program with debugging information. Use GDB to set a watchpoint on a specific element of the array and observe its changes during the program execution.

```c
#include <stdio.h>

#define ARRAY_SIZE 5

int main() {

    int array[ARRAY_SIZE] = {1, 2, 3, 4, 5};


    printf("Original Array: ");
    for (int i = 0; i < ARRAY_SIZE; i++) {
        printf("%d ", array[i]);
    }
    printf("\n");


    for (int i = 0; i < ARRAY_SIZE; i++) {
        array[i] *= 2;
    }


    printf("Modified Array (doubled): ");
    for (int i = 0; i < ARRAY_SIZE; i++) {
        printf("%d ", array[i]);
    }
    printf("\n");

    return 0;
}
```

```
Breakpoint 1, main () at array_operation.c:5
5       int main() {
(gdb) watch array
Hardware watchpoint 2: array
(gdb) s
7           int array[ARRAY_SIZE] = {1, 2, 3, 4, 5};
(gdb)

Hardware watchpoint 2: array

Old value = {0, 0, 0, 0, 0}
New value = {1, 0, 0, 0, 0}
0x00005555555551ab in main () at array_operation.c:7
7           int array[ARRAY_SIZE] = {1, 2, 3, 4, 5};
(gdb)

Hardware watchpoint 2: array

Old value = {1, 0, 0, 0, 0}
New value = {1, 2, 0, 0, 0}
0x00005555555551b2 in main () at array_operation.c:7
7           int array[ARRAY_SIZE] = {1, 2, 3, 4, 5};
(gdb)

Hardware watchpoint 2: array

Old value = {1, 2, 0, 0, 0}
New value = {1, 2, 3, 0, 0}
0x00005555555551b9 in main () at array_operation.c:7
7           int array[ARRAY_SIZE] = {1, 2, 3, 4, 5};
(gdb)

Hardware watchpoint 2: array

Old value = {1, 2, 3, 0, 0}
New value = {1, 2, 3, 4, 0}
0x00005555555551c0 in main () at array_operation.c:7
7           int array[ARRAY_SIZE] = {1, 2, 3, 4, 5};
(gdb)

Hardware watchpoint 2: array
```

```
Old value = {1, 2, 3, 4, 0}
New value = {1, 2, 3, 4, 5}
main () at array_operation.c:10
10          printf("Original Array: ");
(gdb)
__printf (format=0x555555556004 "Original Array: ")
28      ./stdio-common/printf.c: No such file or dir
(gdb)
32      in ./stdio-common/printf.c
(gdb)
33      in ./stdio-common/printf.c
(gdb) n
36      in ./stdio-common/printf.c
(gdb)
main () at array_operation.c:11
11          for (int i = 0; i < ARRAY_SIZE; i++) {
(gdb)
12              printf("%d ", array[i]);
(gdb)
11          for (int i = 0; i < ARRAY_SIZE; i++) {
(gdb)
12              printf("%d ", array[i]);
(gdb)
11          for (int i = 0; i < ARRAY_SIZE; i++) {
(gdb)
12              printf("%d ", array[i]);
(gdb)
11          for (int i = 0; i < ARRAY_SIZE; i++) {
(gdb)
12              printf("%d ", array[i]);
(gdb)
11          for (int i = 0; i < ARRAY_SIZE; i++) {
(gdb)
12              printf("%d ", array[i]);
(gdb)
11          for (int i = 0; i < ARRAY_SIZE; i++) {
(gdb)
14          printf("\n");
(gdb)
Original Array: 1 2 3 4 5
17          for (int i = 0; i < ARRAY_SIZE; i++) {
(gdb)
```

```
(gdb)

Hardware watchpoint 2: array

Old value = {1, 2, 3, 4, 5}
New value = {2, 2, 3, 4, 5}
main () at array_operation.c:17
17          for (int i = 0; i < ARRAY_SIZE; i++) {
(gdb)
18              array[i] *= 2;
(gdb)

Hardware watchpoint 2: array

Old value = {2, 2, 3, 4, 5}
New value = {2, 4, 3, 4, 5}
main () at array_operation.c:17
17          for (int i = 0; i < ARRAY_SIZE; i++) {
(gdb)
18              array[i] *= 2;
(gdb)

Hardware watchpoint 2: array

Old value = {2, 4, 3, 4, 5}
New value = {2, 4, 6, 4, 5}
main () at array_operation.c:17
17          for (int i = 0; i < ARRAY_SIZE; i++) {
(gdb)
18              array[i] *= 2;
(gdb)

Hardware watchpoint 2: array

Old value = {2, 4, 6, 4, 5}
New value = {2, 4, 6, 8, 5}
main () at array_operation.c:17
17          for (int i = 0; i < ARRAY_SIZE; i++) {
(gdb)
18              array[i] *= 2;
(gdb)

Hardware watchpoint 2: array
```

```
Old value = {2, 4, 6, 8, 5}
New value = {2, 4, 6, 8, 10}
main () at array_operation.c:17
17          for (int i = 0; i < ARRAY_SIZE; i++) {
(gdb)
22          printf("Modified Array (doubled): ");
(gdb)
23          for (int i = 0; i < ARRAY_SIZE; i++) {
(gdb)
24              printf("%d ", array[i]);
(gdb)
23          for (int i = 0; i < ARRAY_SIZE; i++) {
(gdb)
24              printf("%d ", array[i]);
(gdb)
23          for (int i = 0; i < ARRAY_SIZE; i++) {
(gdb)
24              printf("%d ", array[i]);
(gdb)
23          for (int i = 0; i < ARRAY_SIZE; i++) {
(gdb)
24              printf("%d ", array[i]);
(gdb)
23          for (int i = 0; i < ARRAY_SIZE; i++) {
(gdb)
24              printf("%d ", array[i]);
(gdb)
23          for (int i = 0; i < ARRAY_SIZE; i++) {
(gdb)
26          printf("\n");
(gdb)
Modified Array (doubled): 2 4 6 8 10
28          return 0;
(gdb)
29      }
(gdb)
```

```
Watchpoint 2 deleted because the program has left the block in
which its expression is valid.
0x00007ffff7c29d90 in __libc_start_call_main (main=main@entry=0x555555555189 <main>, argc=argc@entry=1, argv=argv@entry=0x7fffffffdfb8) at ../sysdeps/nptl/libc_start_call_main.h:58
58      ../sysdeps/nptl/libc_start_call_main.h: No such file or directory.
(gdb)
74      in ../sysdeps/nptl/libc_start_call_main.h
(gdb)
[Inferior 1 (process 4841) exited normally]
```