Embedded linux

Task_1

Static Linking :


```
tarek@tarek-VirtualBox:~/iti/Bishoy/library/staticLib_lab/lib$ gcc -C sub.c -o sub.o
/usr/bin/ld: /usr/lib/gcc/x86_64-linux-gnu/11/../../../x86_64-linux-gnu/Scrt1.o: in function `_start':
(.text+0x1b): undefined reference to `main'
collect2: error: ld returned 1 exit status
tarek@tarek-VirtualBox:~/iti/Bishoy/library/staticLib_lab/lib$ gcc -c sub.c -o sub.o
tarek@tarek-VirtualBox:~/iti/Bishoy/library/staticLib_lab/lib$ gcc -c div.c -o div.o
tarek@tarek-VirtualBox:~/iti/Bishoy/library/staticLib_lab/lib$ gcc -c mult.c -o mult.o
tarek@tarek-VirtualBox:~/iti/Bishoy/library/staticLib_lab/lib$ gcc -c modl.c -o modl.o
tarek@tarek-VirtualBox:~/iti/Bishoy/library/staticLib_lab/lib$ ls
add.c  add.o  div.c  div.o  main.c  modl.c  modl.o  mult.c  mult.o  sub.c  sub.o
tarek@tarek-VirtualBox:~/iti/Bishoy/library/staticLib_lab/lib$ gcc -c main.c -o main.o
tarek@tarek-VirtualBox:~/iti/Bishoy/library/staticLib_lab/lib$ ls
add.c  add.o  div.c  div.o  main.c  main.o  modl.c  modl.o  mult.c  mult.o  sub.c  sub.o
tarek@tarek-VirtualBox:~/iti/Bishoy/library/staticLib_lab/lib$ ar -rcs libCalculator.a add.o sub.o mult.o div.o modl.o
tarek@tarek-VirtualBox:~/iti/Bishoy/library/staticLib_lab/lib$ ls
add.c  add.o  div.c  div.o  libCalculator.a  main.c  main.o  modl.c  modl.o  mult.c  mult.o  sub.c  sub.o
tarek@tarek-VirtualBox:~/iti/Bishoy/library/staticLib_lab/lib$ cat libCalculator.a
!<arch>
/               0           0     0     0       46          `
r~
♦♦♦addsubmultdivmodladd.o/         0           0     0     644     1232        `
ELF>♦@@

        ♦♦UH♦♦}♦♦u♦♦U♦♦E♦♦]♦GCC: (Ubuntu 11.4.0-1ubuntu1~22.04) 11.4.0GNU♦zRx
```



```
tarek@tarek-VirtualBox:~/iti/Bishoy/library/staticLib_lab/lib$ gcc -o main.exe main.o -L. libCaculator.a
/usr/bin/ld: cannot find libCaculator.a: No such file or directory
collect2: error: ld returned 1 exit status
tarek@tarek-VirtualBox:~/iti/Bishoy/library/staticLib_lab/lib$ gcc -o main.exe main.o -L. libCalculator.a
tarek@tarek-VirtualBox:~/iti/Bishoy/library/staticLib_lab/lib$ ls
add.c  add.o  div.c  div.o  libCalculator.a  main.c  main.exe  main.o  modl.c  modl.o  mult.c  mult.o  sub.c  sub.o
tarek@tarek-VirtualBox:~/iti/Bishoy/library/staticLib_lab/lib$ ./main.exe
subtraction = 5
 addition = 15
 multplication = 50
 division = 2
 modulus = 0
tarek@tarek-VirtualBox:~/iti/Bishoy/library/staticLib_lab/lib$
```

Ldd !!

& file

```
modulus = 0
tarek@tarek-VirtualBox:~/iti/Bishoy/library/staticLib_lab/lib$ ldd main.exe
        linux-vdso.so.1 (0x00007ffe1c0de000)
        libc.so.6 => /lib/x86_64-linux-gnu/libc.so.6 (0x00007f0f36c00000)
        /lib64/ld-linux-x86-64.so.2 (0x00007f0f36fcf000)
tarek@tarek-VirtualBox:~/iti/Bishoy/library/staticLib_lab/lib$ file main.exe
main.exe: ELF 64-bit LSB pie executable, x86-64, version 1 (SYSV), dynamically linked, interpreter /lib64/ld-linux-x86-64.so.2, Buil
dID[sha1]=2eab355d7ced0796de310170e219844b2583793d, for GNU/Linux 3.2.0, not stripped
tarek@tarek-VirtualBox:~/iti/Bishoy/library/staticLib_lab/lib$ objdump main.exe
Usage: objdump <option(s)> <file(s)>
 Display information from object <file(s)>.
 At least one of the following switches must be given:
  -a, --archive-headers    Display archive header information
  -f, --file-headers       Display the contents of the overall file header
  -p, --private-headers    Display object format specific file header contents
  -P, --private=OPT,OPT... Display object format specific contents
  -h, --[section-]headers  Display the contents of the section headers
  -x, --all-headers        Display the contents of all headers
  -d, --disassemble        Display assembler contents of executable sections
  -D, --disassemble-all    Display assembler contents of all sections
      --disassemble=<sym>  Display assembler contents from <sym>
  -S, --source             Intermix source code with disassembly
      --source-comment[=<txt>] Prefix lines of source code with <txt>
  -s, --full-contents      Display the full contents of all sections requested
  -g, --debugging          Display debug information in object file
  -e, --debugging-tags     Display debug information using ctags style
  -G, --stabs              Display (in raw form) any STABS info in the file
  -W, --dwarf[a/=abbrev, A/=addr, r/=aranges, c/=cu_index, L/=decodedline,
              f/=frames, F/=frames-interp, g/=gdb_index, i/=info, o/=loc,
              m/=macro, p/=pubnames, t/=pubtypes, R/=Ranges, l/=rawline,
              s/=str, O/=str-offsets, u/=trace_abbrev, T/=trace_aranges,
              U/=trace_info]
                       Display the contents of DWARF debug sections
```

```
  -p, --private-headers    Display object format specific file header contents
  -P, --private=OPT,OPT... Display object format specific contents
  -h, --[section-]headers  Display the contents of the section headers
  -x, --all-headers        Display the contents of all headers
  -d, --disassemble        Display assembler contents of executable sections
  -D, --disassemble-all    Display assembler contents of all sections
      --disassemble=<sym>  Display assembler contents from <sym>
  -S, --source             Intermix source code with disassembly
      --source-comment[=<txt>] Prefix lines of source code with <txt>
  -s, --full-contents      Display the full contents of all sections requested
  -g, --debugging          Display debug information in object file
  -e, --debugging-tags     Display debug information using ctags style
  -G, --stabs              Display (in raw form) any STABS info in the file
  -W, --dwarf[a/=abbrev, A/=addr, r/=aranges, c/=cu_index, L/=decodedline,
              f/=frames, F/=frames-interp, g/=gdb_index, i/=info, o/=loc,
              m/=macro, p/=pubnames, t/=pubtypes, R/=Ranges, l/=rawline,
              s/=str, O/=str-offsets, u/=trace_abbrev, T/=trace_aranges,
              U/=trace_info]
                       Display the contents of DWARF debug sections
  -Wk,--dwarf=links        Display the contents of sections that link to
                           separate debuginfo files
  -WK,--dwarf=follow-links
                       Follow links to separate debug info files (default)
  -WN,--dwarf=no-follow-links
                       Do not follow links to separate debug info files
  -L, --process-links      Display the contents of non-debug sections in
                           separate debuginfo files.  (Implies -WK)
      --ctf[=SECTION]      Display CTF info from SECTION, (default `.ctf')
  -t, --syms               Display the contents of the symbol table(s)
  -T, --dynamic-syms       Display the contents of the dynamic symbol table
  -r, --reloc              Display the relocation entries in the file
  -R, --dynamic-reloc      Display the dynamic relocation entries in the file
  @<file>                  Read options from <file>
  -v, --version            Display this program's version number
  -i, --info               List object formats and architectures supported
  -H, --help               Display this information
tarek@tarek-VirtualBox:~/iti/Bishoy/library/staticLib_lab/lib$
```

Objdump:

```
tarek@tarek-VirtualBox:~/iti/Bishoy/library/staticLib_lab/lib$ objdump -T main_StaticLink.exe

main_StaticLink.exe:     file format elf64-x86-64

DYNAMIC SYMBOL TABLE:
0000000000000000      DF *UND*  0000000000000000 (GLIBC_2.34) __libc_start_main
0000000000000000  w   D  *UND*  0000000000000000  Base        _ITM_deregisterTMCloneTable
0000000000000000      DF *UND*  0000000000000000 (GLIBC_2.2.5) printf
0000000000000000  w   D  *UND*  0000000000000000  Base        __gmon_start__
0000000000000000  w   D  *UND*  0000000000000000  Base        _ITM_registerTMCloneTable
0000000000001268 g    DF .text  0000000000000017  Base        div
0000000000000000  w   DF *UND*  0000000000000000 (GLIBC_2.2.5) __cxa_finalize

tarek@tarek-VirtualBox:~/iti/Bishoy/library/staticLib_lab/lib$ objdump -D main_StaticLink.exe
```

Dynamic Linking:

```
                    tarek@tarek-VirtualBox: ~/iti/Bishoy/library/staticLib_lab/lib
collect2: error: ld returned 1 exit status
tarek@tarek-VirtualBox:~/iti/Bishoy/library/staticLib_lab/lib$ gcc -o main_DynamicLink.exe main
.o -L. -lCalculator
tarek@tarek-VirtualBox:~/iti/Bishoy/library/staticLib_lab/lib$ ls
add.c  div.c  libCalculator.a   main.c              main.o          modl.c  mult.c  sub.
c
add.o  div.o  libCalculator.so  main_DynamicLink.exe  main_StaticLink.exe  modl.o  mult.o  sub.
o
tarek@tarek-VirtualBox:~/iti/Bishoy/library/staticLib_lab/lib$ ./main_DynamicLink.exe
./main_DynamicLink.exe: error while loading shared libraries: libCalculator.so: cannot open sha
red object file: No such file or directory
tarek@tarek-VirtualBox:~/iti/Bishoy/library/staticLib_lab/lib$ ldd main_DynamicLink.exe
        linux-vdso.so.1 (0x00007ffc2a4ac000)
        libCalculator.so => not found
        libc.so.6 => /lib/x86_64-linux-gnu/libc.so.6 (0x00007f87e9c00000)
        /lib64/ld-linux-x86-64.so.2 (0x00007f87e9f73000)
tarek@tarek-VirtualBox:~/iti/Bishoy/library/staticLib_lab/lib$ sudo cp libCalculator.so /usr/li
b
[sudo] password for tarek:
tarek@tarek-VirtualBox:~/iti/Bishoy/library/staticLib_lab/lib$ ./main_DynamicLink.exe
subtraction = 5
 addition = 15
 multplication = 50
 division = 2
```

Ldd & file commands

```
divtston = 2
modulus = 0
tarek@tarek-VirtualBox:~/iti/Bishoy/library/staticLib_lab/lib$ sudo rm /usr/lib/libCalculator.
so
tarek@tarek-VirtualBox:~/iti/Bishoy/library/staticLib_lab/lib$ ./main_DynamicLink.exe
./main_DynamicLink.exe: error while loading shared libraries: libCalculator.so: cannot open sha
red object file: No such file or directory
tarek@tarek-VirtualBox:~/iti/Bishoy/library/staticLib_lab/lib$ pwd
/home/tarek/iti/Bishoy/library/staticLib_lab/lib
tarek@tarek-VirtualBox:~/iti/Bishoy/library/staticLib_lab/lib$ export LD_LIBRARY_PATH=:/home/ta
rek/iti/Bishoy/library/staticLib_lab/lib
tarek@tarek-VirtualBox:~/iti/Bishoy/library/staticLib_lab/lib$ ./main_DynamicLink.exe
subtraction = 5
 addition = 15
 multplication = 50
 division = 2
 modulus = 0
tarek@tarek-VirtualBox:~/iti/Bishoy/library/staticLib_lab/lib$ ldd main_DynamicLink.exe
        linux-vdso.so.1 (0x00007fff386a9000)
        libCalculator.so (0x00007f66edf97000)
        libc.so.6 => /lib/x86_64-linux-gnu/libc.so.6 (0x00007f66edc00000)
        /lib64/ld-linux-x86-64.so.2 (0x00007f66edfa3000)
tarek@tarek-VirtualBox:~/iti/Bishoy/library/staticLib_lab/lib$ file main_DynamicLink.exe
main_DynamicLink.exe: ELF 64-bit LSB pie executable, x86-64, version 1 (SYSV), dynamically link
ed  interpreter /lib64/ld-linux-x86_64_so_2  BuildID[sha1]_bdc271017069c7a22176f501cdfe43147e2f
```

```
        /lib64/ld-linux-x86-64.so.2 (0x00007f66edfa3000)
tarek@tarek-VirtualBox:~/iti/Bishoy/library/staticLib_lab/lib$ file main_DynamicLink.exe
main_DynamicLink.exe: ELF 64-bit LSB pie executable, x86-64, version 1 (SYSV), dynamically link
ed, interpreter /lib64/ld-linux-x86-64.so.2, BuildID[sha1]=bdc271017069c7a22176f501cdfe43147e2f
2380, for GNU/Linux 3.2.0, not stripped
tarek@tarek-VirtualBox:~/iti/Bishoy/library/staticLib_lab/lib$ objdump main_DynamicLink.exe
Usage: objdump <option(s)> <file(s)>
 Display information from object <file(s)>.
 At least one of the following switches must be given:
  -a, --archive-headers    Display archive header information
  -f, --file-headers       Display the contents of the overall file header
  -p, --private-headers    Display object format specific file header contents
  -P, --private=OPT,OPT... Display object format specific contents
  -h, --[section-]headers  Display the contents of the section headers
  -x, --all-headers        Display the contents of all headers
  -d, --disassemble        Display assembler contents of executable sections
  -D, --disassemble-all    Display assembler contents of all sections
      --disassemble=<sym>  Display assembler contents from <sym>
  -S, --source             Intermix source code with disassembly
      --source-comment[=<txt>] Prefix lines of source code with <txt>
  -s, --full-contents      Display the full contents of all sections requested
  -g, --debugging          Display debug information in object file
  -e, --debugging-tags     Display debug information using ctags style
  -G, --stabs              Display (in raw form) any STABS info in the file
```

```
--source-comment[=<txt>] Prefix lines of source code with <txt>
-s, --full-contents      Display the full contents of all sections requested
-g, --debugging          Display debug information in object file
-e, --debugging-tags     Display debug information using ctags style
-G, --stabs              Display (in raw form) any STABS info in the file
-W, --dwarf[a/=abbrev, A/=addr, r/=aranges, c/=cu_index, L/=decodedline,
            f/=frames, F/=frames-interp, g/=gdb_index, i/=info, o/=loc,
            m/=macro, p/=pubnames, t/=pubtypes, R/=Ranges, l/=rawline,
            s/=str, O/=str-offsets, u/=trace_abbrev, T/=trace_aranges,
            U/=trace_info]
                         Display the contents of DWARF debug sections
-Wk,--dwarf=links        Display the contents of sections that link to
                          separate debuginfo files
-WK,--dwarf=follow-links
                         Follow links to separate debug info files (default)
-WN,--dwarf=no-follow-links
                         Do not follow links to separate debug info files
-L, --process-links      Display the contents of non-debug sections in
                          separate debuginfo files.  (Implies -WK)
    --ctf[=SECTION]      Display CTF info from SECTION, (default `.ctf')
-t, --syms               Display the contents of the symbol table(s)
-T, --dynamic-syms       Display the contents of the dynamic symbol table
-r, --reloc              Display the relocation entries in the file
-R, --dynamic-reloc      Display the dynamic relocation entries in the file
@<file>                  Read options from <file>
```

```
-W, --dwarf[a/=abbrev, A/=addr, r/=aranges, c/=cu_index, L/=decodedline,
            f/=frames, F/=frames-interp, g/=gdb_index, i/=info, o/=loc,
            m/=macro, p/=pubnames, t/=pubtypes, R/=Ranges, l/=rawline,
            s/=str, O/=str-offsets, u/=trace_abbrev, T/=trace_aranges,
            U/=trace_info]
                         Display the contents of DWARF debug sections
-Wk,--dwarf=links        Display the contents of sections that link to
                          separate debuginfo files
-WK,--dwarf=follow-links
                         Follow links to separate debug info files (default)
-WN,--dwarf=no-follow-links
                         Do not follow links to separate debug info files
-L, --process-links      Display the contents of non-debug sections in
                          separate debuginfo files.  (Implies -WK)
    --ctf[=SECTION]      Display CTF info from SECTION, (default `.ctf')
-t, --syms               Display the contents of the symbol table(s)
-T, --dynamic-syms       Display the contents of the dynamic symbol table
-r, --reloc              Display the relocation entries in the file
-R, --dynamic-reloc      Display the dynamic relocation entries in the file
@<file>                  Read options from <file>
-v, --version            Display this program's version number
-i, --info               List object formats and architectures supported
-H, --help               Display this information
tarek@tarek-VirtualBox:~/iti/Bishoy/library/staticLib_lab/lib$
```

Objdump command with –T option:


```
tarek@tarek-VirtualBox:~/iti/Bishoy/library/staticLib_lab/lib$ objdump -T main_DynamicLink.exe

main_DynamicLink.exe:     file format elf64-x86-64

DYNAMIC SYMBOL TABLE:
0000000000000000      DF *UND*  0000000000000000 (GLIBC_2.34) __libc_start_main
0000000000000000  w   D  *UND*  0000000000000000  Base        _ITM_deregisterTMCloneTable
0000000000000000      DF *UND*  0000000000000000  Base        add
0000000000000000      DF *UND*  0000000000000000  Base        modl
0000000000000000      DF *UND*  0000000000000000  Base        div
0000000000000000      DF *UND*  0000000000000000 (GLIBC_2.2.5) printf
0000000000000000  w   D  *UND*  0000000000000000  Base        __gmon_start__
0000000000000000      DF *UND*  0000000000000000  Base        mult
0000000000000000  w   D  *UND*  0000000000000000  Base        _ITM_registerTMCloneTable
0000000000000000      DF *UND*  0000000000000000  Base        sub
0000000000000000  w   DF *UND*  0000000000000000 (GLIBC_2.2.5) __cxa_finalize

tarek@tarek-VirtualBox:~/iti/Bishoy/library/staticLib_lab/lib$
```