LAB2

1- Compiling the c files, getting the object files, linking all files with startup file and linker script file, and the generate the binary file using Makefile command.

```
Abdo Halem@Halem-Lab /cygdrive/d/Engineering/Embedded_Systems/Eng Kerolos_Diploma/Lectures/Unit3/Lesson3/Lab2
$ make
arm-none-eabi-gcc -c -gdwarf-2 -mcpu=cortex-m3 -mthumb -I . main.c -o main.o
arm-none-eabi-gcc -c -gdwarf-2 -mcpu=cortex-m3 -mthumb -I . startup.c -o startup.o
arm-none-eabi-ld -T linker_script.ld   main.o startup.o  -o learn-in-depth_cortex_m3.elf -Map=Map_file.map
arm-none-eabi-objcopy -O binary learn-in-depth_cortex_m3.elf learn-in-depth_cortex_m3.bin
=========Build is Done=========

Abdo Halem@Halem-Lab /cygdrive/d/Engineering/Embedded_Systems/Eng Kerolos_Diploma/Lectures/Unit3/Lesson3/Lab2
$
```

2- analyze memory sections of each file.

```
Abdo Halem@Halem-Lab /cygdrive/d/Engineering/Embedded_Systems/Eng Kerolos_Diploma/Lectures/Unit3/Lesson3/Lab2
$ arm-none-eabi-objdump -h main.o

main.o:     file format elf32-littlearm

Sections:
Idx Name          Size      VMA       LMA       File off  Algn
  0 .text         000000b0  00000000  00000000  00000034  2**2
                  CONTENTS, ALLOC, LOAD, RELOC, READONLY, CODE
  1 .data         00000008  00000000  00000000  000000e4  2**2
                  CONTENTS, ALLOC, LOAD, DATA
  2 .bss          00000000  00000000  00000000  000000ec  2**0
                  ALLOC
  3 .rodata       00000004  00000000  00000000  000000ec  2**2
                  CONTENTS, ALLOC, LOAD, READONLY, DATA
  4 .debug_info   0000016e  00000000  00000000  000000f0  2**0
                  CONTENTS, RELOC, READONLY, DEBUGGING
  5 .debug_abbrev 000000ee  00000000  00000000  0000025e  2**0
                  CONTENTS, READONLY, DEBUGGING
  6 .debug_loc    00000038  00000000  00000000  0000034c  2**0
                  CONTENTS, READONLY, DEBUGGING
  7 .debug_aranges 00000020  00000000  00000000  00000384  2**0
                  CONTENTS, RELOC, READONLY, DEBUGGING
  8 .debug_line   0000009c  00000000  00000000  000003a4  2**0
                  CONTENTS, RELOC, READONLY, DEBUGGING
  9 .debug_str    0000014b  00000000  00000000  00000440  2**0
                  CONTENTS, READONLY, DEBUGGING
 10 .comment      00000012  00000000  00000000  0000058b  2**0
                  CONTENTS, READONLY
 11 .ARM.attributes 00000033  00000000  00000000  0000059d  2**0
                  CONTENTS, READONLY
 12 .debug_frame  0000002c  00000000  00000000  000005d0  2**2
                  CONTENTS, RELOC, READONLY, DEBUGGING
```

```
Abdo Halem@Halem-Lab /cygdrive/d/Engineering/Embedded_Systems/Eng Kerolos_Diploma/Lectures/Unit3/Lesson3/Lab2
$ arm-none-eabi-objdump -h startup.o

startup.o:     file format elf32-littlearm

Sections:
Idx Name          Size      VMA       LMA       File off  Algn
  0 .text         000000c4  00000000  00000000  00000034  2**2
                  CONTENTS, ALLOC, LOAD, RELOC, READONLY, CODE
  1 .data         00000000  00000000  00000000  000000f8  2**0
                  CONTENTS, ALLOC, LOAD, DATA
  2 .bss          00000000  00000000  00000000  000000f8  2**0
                  ALLOC
  3 .vectors      0000001c  00000000  00000000  000000f8  2**2
                  CONTENTS, ALLOC, LOAD, RELOC, DATA
  4 .debug_info   00000167  00000000  00000000  00000114  2**0
                  CONTENTS, RELOC, READONLY, DEBUGGING
  5 .debug_abbrev 000000c0  00000000  00000000  0000027b  2**0
                  CONTENTS, READONLY, DEBUGGING
  6 .debug_loc    00000064  00000000  00000000  0000033b  2**0
                  CONTENTS, READONLY, DEBUGGING
  7 .debug_aranges 00000020  00000000  00000000  0000039f  2**0
                  CONTENTS, RELOC, READONLY, DEBUGGING
  8 .debug_line   000000ad  00000000  00000000  000003bf  2**0
                  CONTENTS, RELOC, READONLY, DEBUGGING
  9 .debug_str    00000172  00000000  00000000  0000046c  2**0
                  CONTENTS, READONLY, DEBUGGING
 10 .comment      00000012  00000000  00000000  000005de  2**0
                  CONTENTS, READONLY
 11 .ARM.attributes 00000033  00000000  00000000  000005f0  2**0
                  CONTENTS, READONLY
 12 .debug_frame  0000004c  00000000  00000000  00000624  2**2
                  CONTENTS, RELOC, READONLY, DEBUGGING

Abdo Halem@Halem-Lab /cygdrive/d/Engineering/Embedded_Systems/Eng Kerolos_Diploma/Lectures/Unit3/Lesson3/Lab2
$
```

```
Abdo Halem@Halem-Lab /cygdrive/d/Engineering/Embedded_Systems/Eng Kerolos_Diploma/Lectures/Unit3/Lesson3/Lab2
$ arm-none-eabi-objdump -h learn-in-depth_cortex_m3.elf

learn-in-depth_cortex_m3.elf:     file format elf32-littlearm

Sections:
Idx Name          Size      VMA       LMA       File off  Algn
  0 .text         00000194  08000000  08000000  00008000  2**2
                  CONTENTS, ALLOC, LOAD, READONLY, CODE
  1 .data         00000008  20000000  08000194  00010000  2**2
                  CONTENTS, ALLOC, LOAD, DATA
  2 .bss          000003e8  20000008  0800019c  00010008  2**0
                  ALLOC
  3 .debug_info   000002d5  00000000  00000000  00010008  2**0
                  CONTENTS, READONLY, DEBUGGING
  4 .debug_abbrev 000001ae  00000000  00000000  000102dd  2**0
                  CONTENTS, READONLY, DEBUGGING
  5 .debug_loc    0000009c  00000000  00000000  0001048b  2**0
                  CONTENTS, READONLY, DEBUGGING
  6 .debug_aranges 00000040  00000000  00000000  00010527  2**0
                  CONTENTS, READONLY, DEBUGGING
  7 .debug_line   00000149  00000000  00000000  00010567  2**0
                  CONTENTS, READONLY, DEBUGGING
  8 .debug_str    0000018e  00000000  00000000  000106b0  2**0
                  CONTENTS, READONLY, DEBUGGING
  9 .comment      00000011  00000000  00000000  0001083e  2**0
                  CONTENTS, READONLY
 10 .ARM.attributes 00000033  00000000  00000000  0001084f  2**0
                  CONTENTS, READONLY
 11 .debug_frame  00000078  00000000  00000000  00010884  2**2
                  CONTENTS, READONLY, DEBUGGING

Abdo Halem@Halem-Lab /cygdrive/d/Engineering/Embedded_Systems/Eng Kerolos_Diploma/Lectures/Unit3/Lesson3/Lab2
$
```

3- Getting the symbol table of each file.

```
Abdo Halem@Halem-Lab /cygdrive/d/Engineering/Embedded_Systems/Eng Kerolos_Diploma/Lectures/Unit3/Lesson3/Lab2
$ arm-none-eabi-nm main.o
00000000 R const_variables
00000004 D g_variables
00000000 T main
00000000 D R_ODR

Abdo Halem@Halem-Lab /cygdrive/d/Engineering/Embedded_Systems/Eng Kerolos_Diploma/Lectures/Unit3/Lesson3/Lab2
$ arm-none-eabi-nm startup.o
         U _E_bss
         U _E_DATA
         U _E_text
         U _S_bss
         U _S_DATA
         U _stack_top
00000000 W Bus_Fault_Handler
00000000 T Default_Handler
00000000 W H_Fault_Handler
         U main
00000000 W MM_Fault_Handler
00000000 W NMI_Handler
0000000c T Reset_Handler
00000000 W Usage_Fault_Handler
00000000 D vectors

Abdo Halem@Halem-Lab /cygdrive/d/Engineering/Embedded_Systems/Eng Kerolos_Diploma/Lectures/Unit3/Lesson3/Lab2
$ arm-none-eabi-nm learn-in-depth_cortex_m3.elf
20000008 B _E_bss
20000008 D _E_DATA
08000194 T _E_text
20000008 B _S_bss
20000000 D _S_DATA
200003f0 B _stack_top
080000cc W Bus_Fault_Handler
08000190 T const_variables
080000cc T Default_Handler
20000004 D g_variables
080000cc W H_Fault_Handler
0800001c T main
080000cc W MM_Fault_Handler
080000cc W NMI_Handler
20000000 D R_ODR
080000d8 T Reset_Handler
080000cc W Usage_Fault_Handler
08000000 T vectors

Abdo Halem@Halem-Lab /cygdrive/d/Engineering/Embedded_Systems/Eng Kerolos_Diploma/Lectures/Unit3/Lesson3/Lab2
$
```

4- Analyze the final elf file.

```
Abdo Halem@Halem-Lab /cygdrive/d/Engineering/Embedded_Systems/Eng Kerolos_Diploma/Lectures/Unit3/Lesson3/Lab2
$ arm-none-eabi-readelf -a learn-in-depth_cortex_m3.elf
ELF Header:
  Magic:   7f 45 4c 46 01 01 01 00 00 00 00 00 00 00 00 00
  Class:                             ELF32
  Data:                              2's complement, little endian
  Version:                           1 (current)
  OS/ABI:                            UNIX - System V
  ABI Version:                       0
  Type:                              EXEC (Executable file)
  Machine:                           ARM
  Version:                           0x1
  Entry point address:               0x8000000
  Start of program headers:          52 (bytes into file)
  Start of section headers:          67996 (bytes into file)
  Flags:                             0x5000002, has entry point, Version5 EABI
  Size of this header:               52 (bytes)
  Size of program headers:           32 (bytes)
  Number of program headers:         2
  Size of section headers:           40 (bytes)
  Number of section headers:         16
  Section header string table index: 13

Section Headers:
  [Nr] Name              Type            Addr     Off    Size   ES Flg Lk Inf Al
  [ 0]                   NULL            00000000 000000 000000 00      0   0  0
  [ 1] .text             PROGBITS        08000000 008000 000194 00  AX  0   0  4
  [ 2] .data             PROGBITS        20000000 010000 000008 00  WA  0   0  4
  [ 3] .bss              NOBITS          20000008 010008 0003e8 00  WA  0   0  1
  [ 4] .debug_info       PROGBITS        00000000 010008 0002d5 00      0   0  1
  [ 5] .debug_abbrev     PROGBITS        00000000 0102dd 0001ae 00      0   0  1
  [ 6] .debug_loc        PROGBITS        00000000 01048b 00009c 00      0   0  1
  [ 7] .debug_aranges    PROGBITS        00000000 010527 000040 00      0   0  1
  [ 8] .debug_line       PROGBITS        00000000 010567 000149 00      0   0  1
  [ 9] .debug_str        PROGBITS        00000000 0106b0 00018e 01  MS  0   0  1
  [10] .comment          PROGBITS        00000000 01083e 000011 01  MS  0   0  1
  [11] .ARM.attributes   ARM_ATTRIBUTES  00000000 01084f 000033 00      0   0  1
  [12] .debug_frame      PROGBITS        00000000 010884 000078 00      0   0  4
  [13] .shstrtab         STRTAB          00000000 0108fc 00009d 00      0   0  1
  [14] .symtab           SYMTAB          00000000 010c1c 000290 10     15  23  4
  [15] .strtab           STRTAB          00000000 010eac 0000e9 00      0   0  1
Key to Flags:
  W (write), A (alloc), X (execute), M (merge), S (strings)
  I (info), L (link order), G (group), T (TLS), E (exclude), x (unknown)
  O (extra OS processing required) o (OS specific), p (processor specific)

There are no section groups in this file.

Program Headers:
  Type           Offset   VirtAddr   PhysAddr   FileSiz MemSiz  Flg Align
  LOAD           0x008000 0x08000000 0x08000000 0x00194 0x00194 R E 0x8000
  LOAD           0x010000 0x20000000 0x08000194 0x00008 0x003f0 RW  0x8000

 Section to Segment mapping:
  Segment Sections...
   00     .text
   01     .data .bss
```

```
Program Headers:
  Type           Offset   VirtAddr   PhysAddr   FileSiz MemSiz  Flg Align
  LOAD           0x008000 0x08000000 0x08000000 0x00194 0x00194 R E 0x8000
  LOAD           0x010000 0x20000000 0x08000194 0x00008 0x003f0 RW  0x8000

 Section to Segment mapping:
  Segment Sections...
   00     .text
   01     .data .bss

There is no dynamic section in this file.

There are no relocations in this file.

There are no unwind sections in this file.

Symbol table '.symtab' contains 41 entries:
   Num:    Value  Size Type    Bind   Vis      Ndx Name
     0: 00000000     0 NOTYPE  LOCAL  DEFAULT  UND
     1: 08000000     0 SECTION LOCAL  DEFAULT    1
     2: 20000000     0 SECTION LOCAL  DEFAULT    2
     3: 20000008     0 SECTION LOCAL  DEFAULT    3
     4: 00000000     0 SECTION LOCAL  DEFAULT    4
     5: 00000000     0 SECTION LOCAL  DEFAULT    5
     6: 00000000     0 SECTION LOCAL  DEFAULT    6
     7: 00000000     0 SECTION LOCAL  DEFAULT    7
     8: 00000000     0 SECTION LOCAL  DEFAULT    8
     9: 00000000     0 SECTION LOCAL  DEFAULT    9
    10: 00000000     0 SECTION LOCAL  DEFAULT   10
    11: 00000000     0 SECTION LOCAL  DEFAULT   11
    12: 00000000     0 SECTION LOCAL  DEFAULT   12
    13: 00000000     0 FILE    LOCAL  DEFAULT  ABS startup.c
    14: 080000cc     0 NOTYPE  LOCAL  DEFAULT    1 $t
    15: 08000000     0 NOTYPE  LOCAL  DEFAULT    1 $d
    16: 0000003c     0 NOTYPE  LOCAL  DEFAULT   12 $d
    17: 00000000     0 FILE    LOCAL  DEFAULT  ABS main.c
    18: 20000000     0 NOTYPE  LOCAL  DEFAULT    2 $d
    19: 08000190     0 NOTYPE  LOCAL  DEFAULT    1 $d
    20: 0800001c     0 NOTYPE  LOCAL  DEFAULT    1 $t
    21: 00000010     0 NOTYPE  LOCAL  DEFAULT   12 $d
    22: 00000000     0 FILE    LOCAL  DEFAULT  ABS
    23: 080000cd    10 FUNC    WEAK   DEFAULT    1 NMI_Handler
    24: 08000190     3 OBJECT  GLOBAL DEFAULT    1 const_variables
    25: 080000cd    10 FUNC    WEAK   DEFAULT    1 Bus_Fault_Handler
    26: 080000cd    10 FUNC    WEAK   DEFAULT    1 H_Fault_Handler
    27: 20000008     0 NOTYPE  GLOBAL DEFAULT    3 _E_bss
    28: 20000004     3 OBJECT  GLOBAL DEFAULT    2 g_variables
    29: 080000cd    10 FUNC    WEAK   DEFAULT    1 MM_Fault_Handler
    30: 080000d9   182 FUNC    GLOBAL DEFAULT    1 Reset_Handler
    31: 200003f0     0 NOTYPE  GLOBAL DEFAULT    3 _stack_top
    32: 20000008     0 NOTYPE  GLOBAL DEFAULT    2 _E_DATA
    33: 080000cd    10 FUNC    GLOBAL DEFAULT    1 Default_Handler
    34: 20000008     0 NOTYPE  GLOBAL DEFAULT    3 _S_bss
    35: 0800001d   174 FUNC    GLOBAL DEFAULT    1 main
    36: 20000000     4 OBJECT  GLOBAL DEFAULT    2 R_ODR
    37: 080000cd    10 FUNC    WEAK   DEFAULT    1 Usage_Fault_Handler
    38: 20000000     0 NOTYPE  GLOBAL DEFAULT    2 _S_DATA
    39: 08000194     0 NOTYPE  GLOBAL DEFAULT    1 _E_text
```

```
Abdo Halem@Halem-Lab /cygdrive/d/Engineering/Embedded_Systems/Eng Kerolos_Diploma/Lectures/Unit3/Lesson3/Lab2
$ arm-none-eabi-objdump -h learn-in-depth_cortex_m3.elf

learn-in-depth_cortex_m3.elf:     file format elf32-littlearm

Sections:
Idx Name          Size      VMA       LMA       File off  Algn
  0 .text         00000194  08000000  08000000  00008000  2**2
                  CONTENTS, ALLOC, LOAD, READONLY, CODE
  1 .data         00000008  20000000  08000194  00010000  2**2
                  CONTENTS, ALLOC, LOAD, DATA
  2 .bss          000003e8  20000008  0800019c  00010008  2**0
                  ALLOC
  3 .debug_info   000002d5  00000000  00000000  00010008  2**0
                  CONTENTS, READONLY, DEBUGGING
  4 .debug_abbrev 000001ae  00000000  00000000  000102dd  2**0
                  CONTENTS, READONLY, DEBUGGING
  5 .debug_loc    0000009c  00000000  00000000  0001048b  2**0
                  CONTENTS, READONLY, DEBUGGING
  6 .debug_aranges 00000040  00000000  00000000  00010527  2**0
                  CONTENTS, READONLY, DEBUGGING
  7 .debug_line   00000149  00000000  00000000  00010567  2**0
                  CONTENTS, READONLY, DEBUGGING
  8 .debug_str    0000018e  00000000  00000000  000106b0  2**0
                  CONTENTS, READONLY, DEBUGGING
  9 .comment      00000011  00000000  00000000  0001083e  2**0
                  CONTENTS, READONLY
 10 .ARM.attributes 00000033  00000000  00000000  0001084f  2**0
                  CONTENTS, READONLY
 11 .debug_frame  00000078  00000000  00000000  00010884  2**2
                  CONTENTS, READONLY, DEBUGGING

Abdo Halem@Halem-Lab /cygdrive/d/Engineering/Embedded_Systems/Eng Kerolos_Diploma/Lectures/Unit3/Lesson3/Lab2
$
```