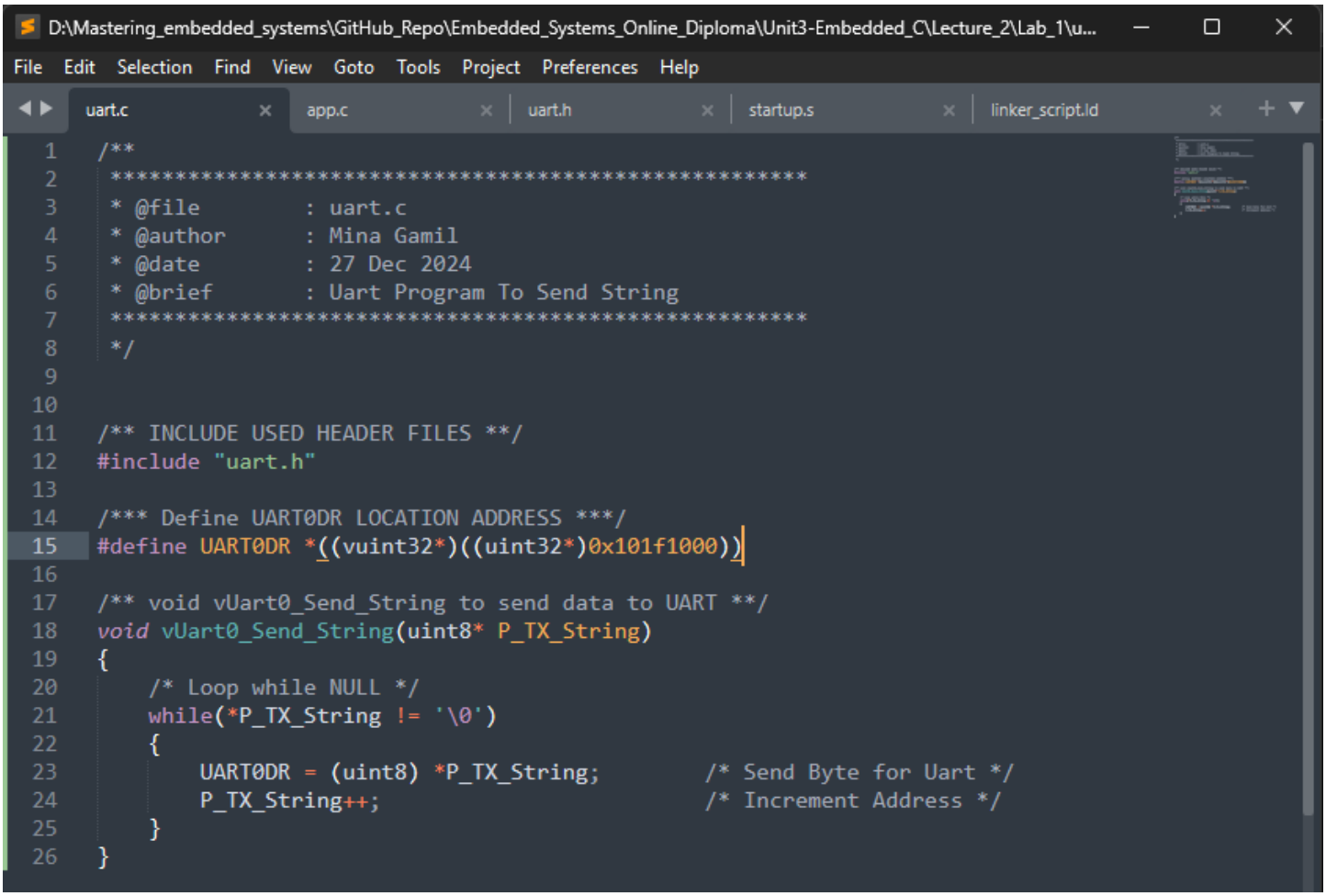
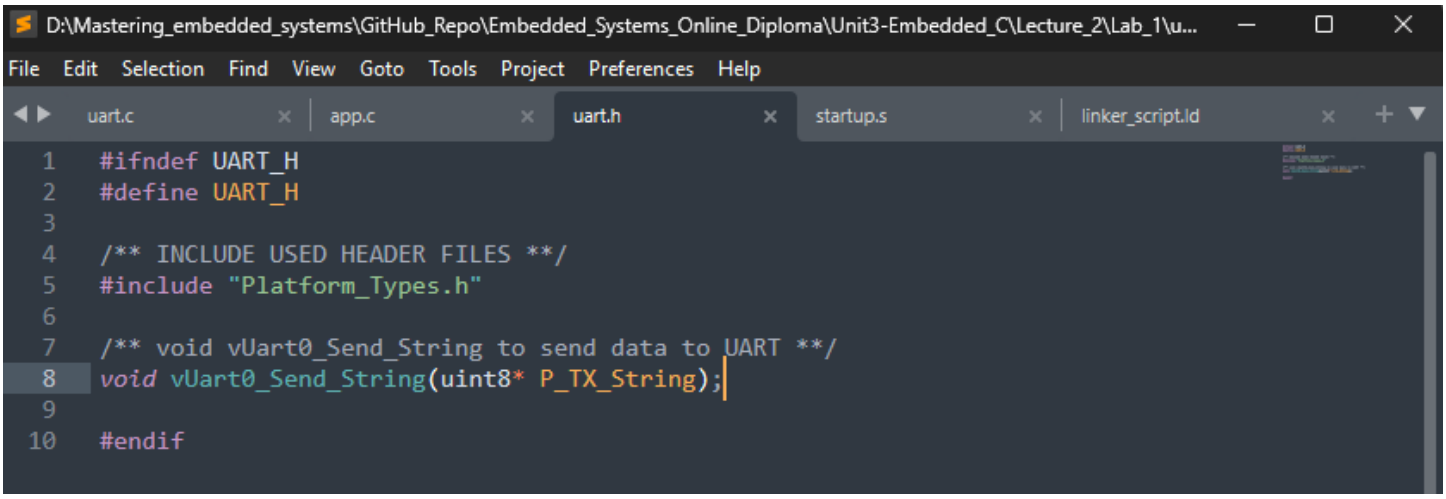
Unit3_Lesson2_Lab_1

1. Code Files

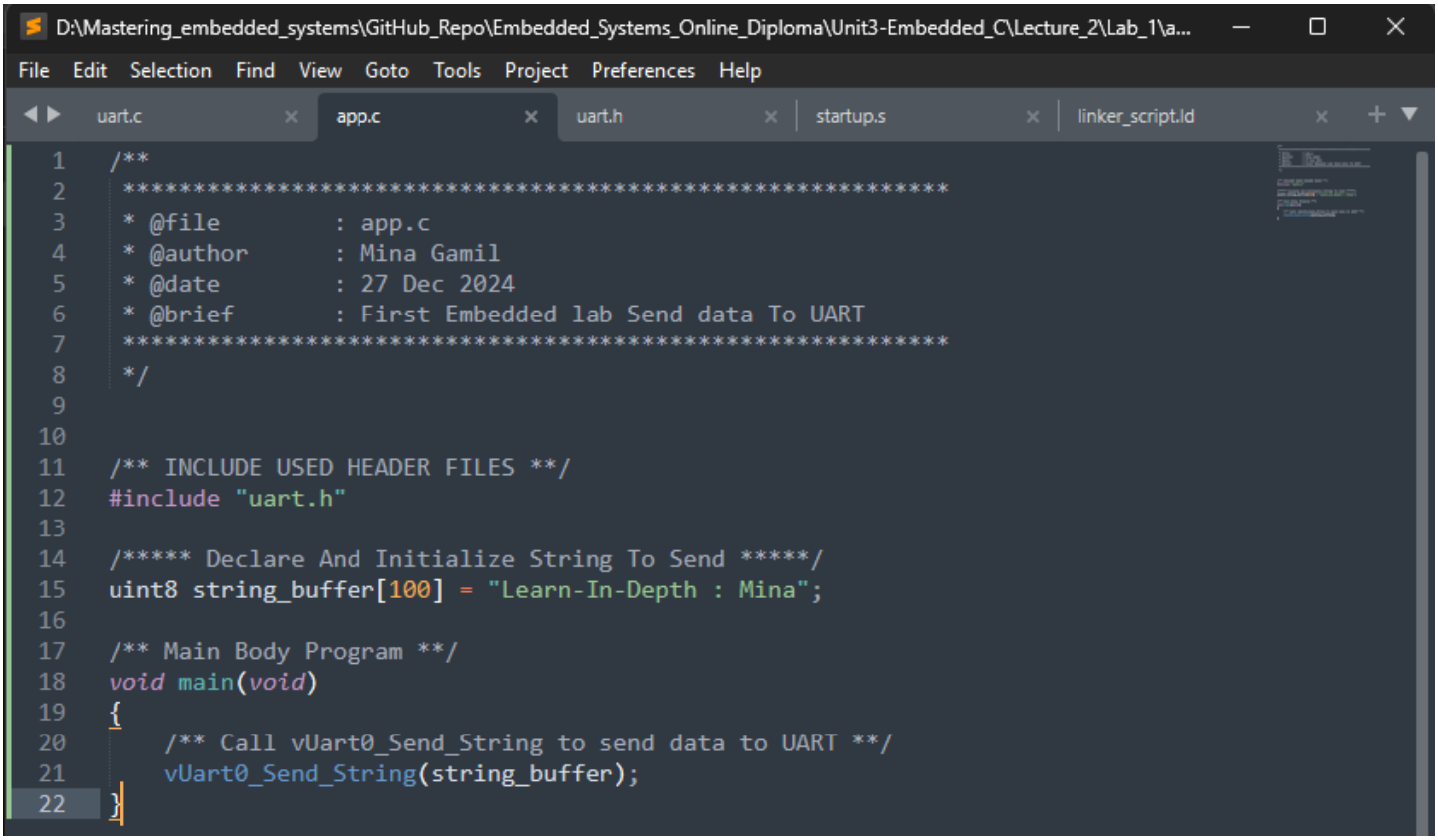
1.1: uart.c



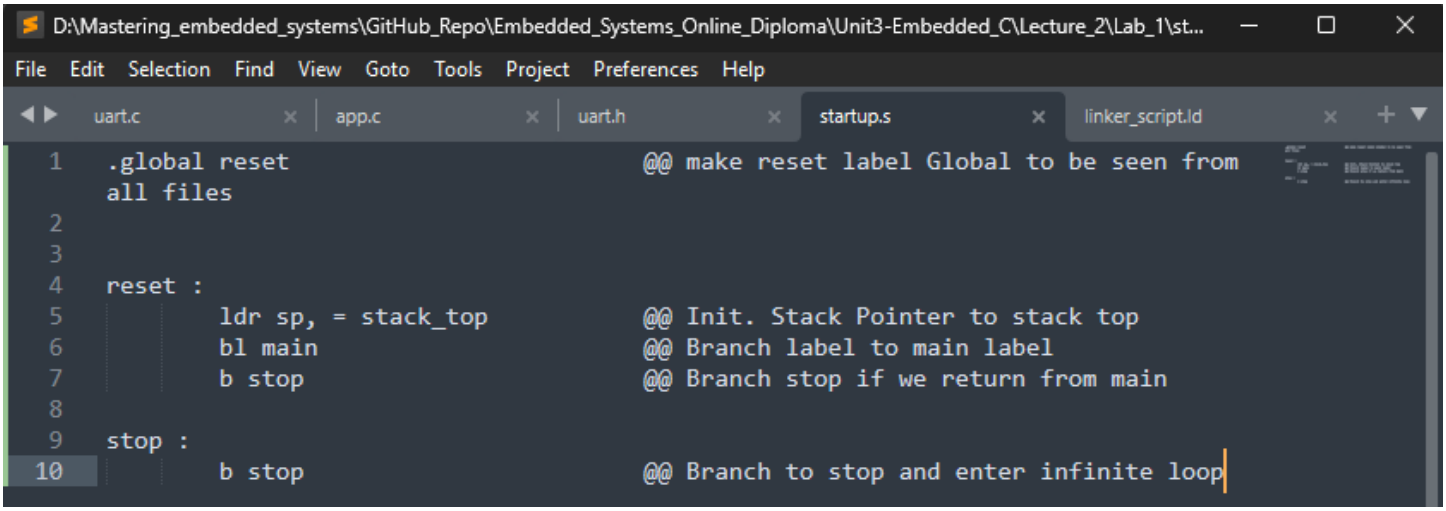
1.2: uart.h



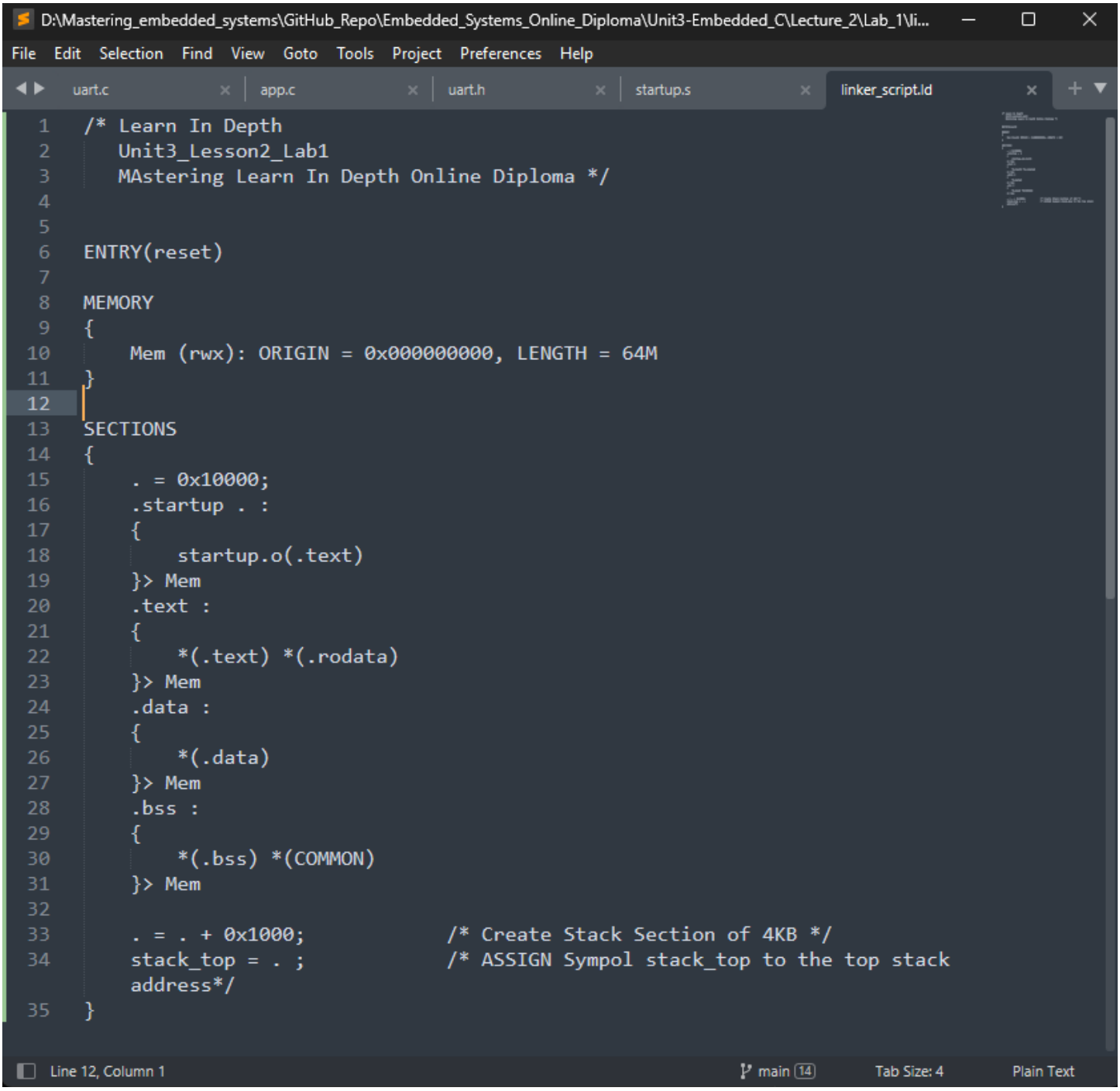
1.3: app.c



1.4: startup.s

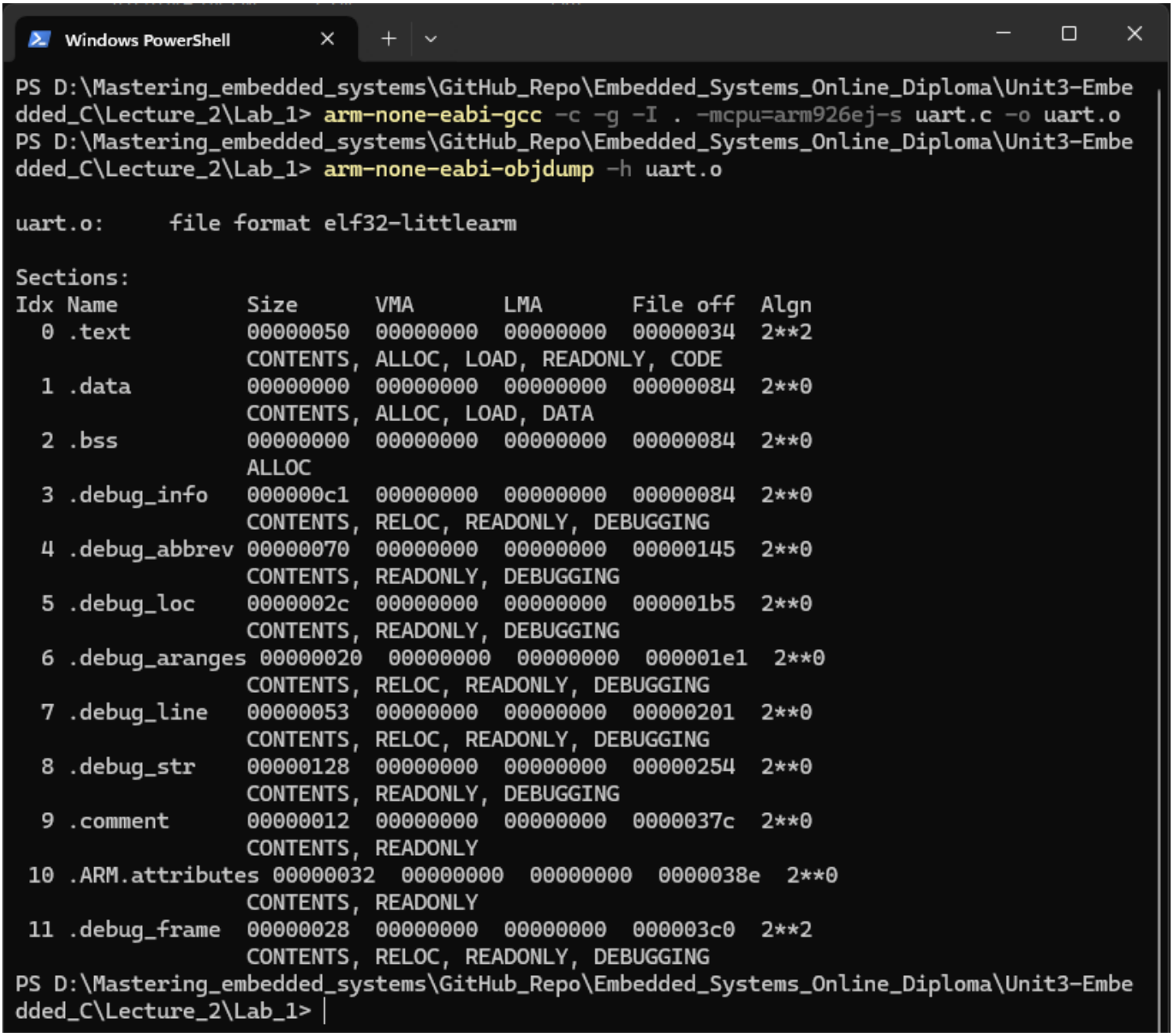


1.5: linker_script.ls

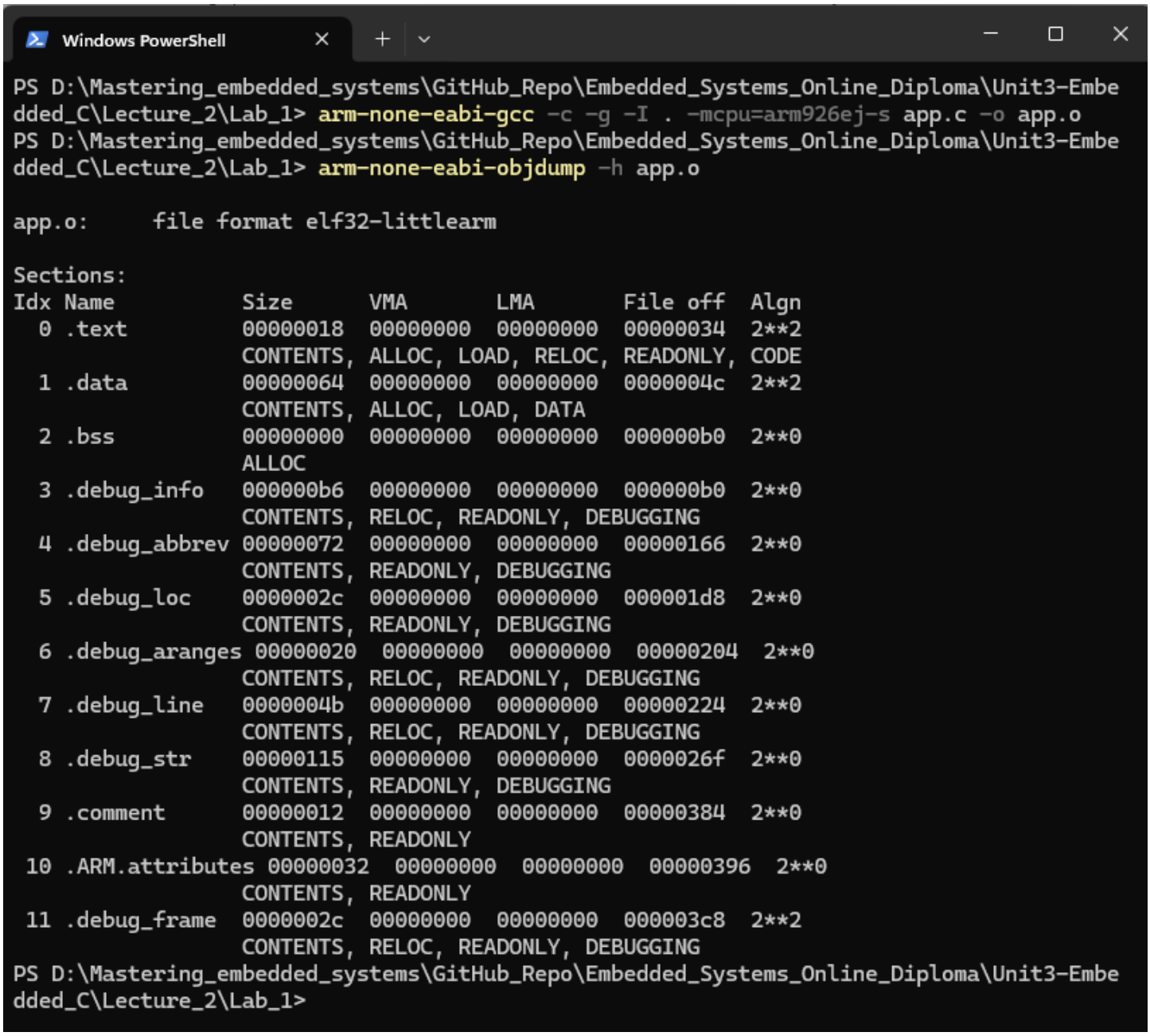


2. Object Files and Sections analyze with debug sections

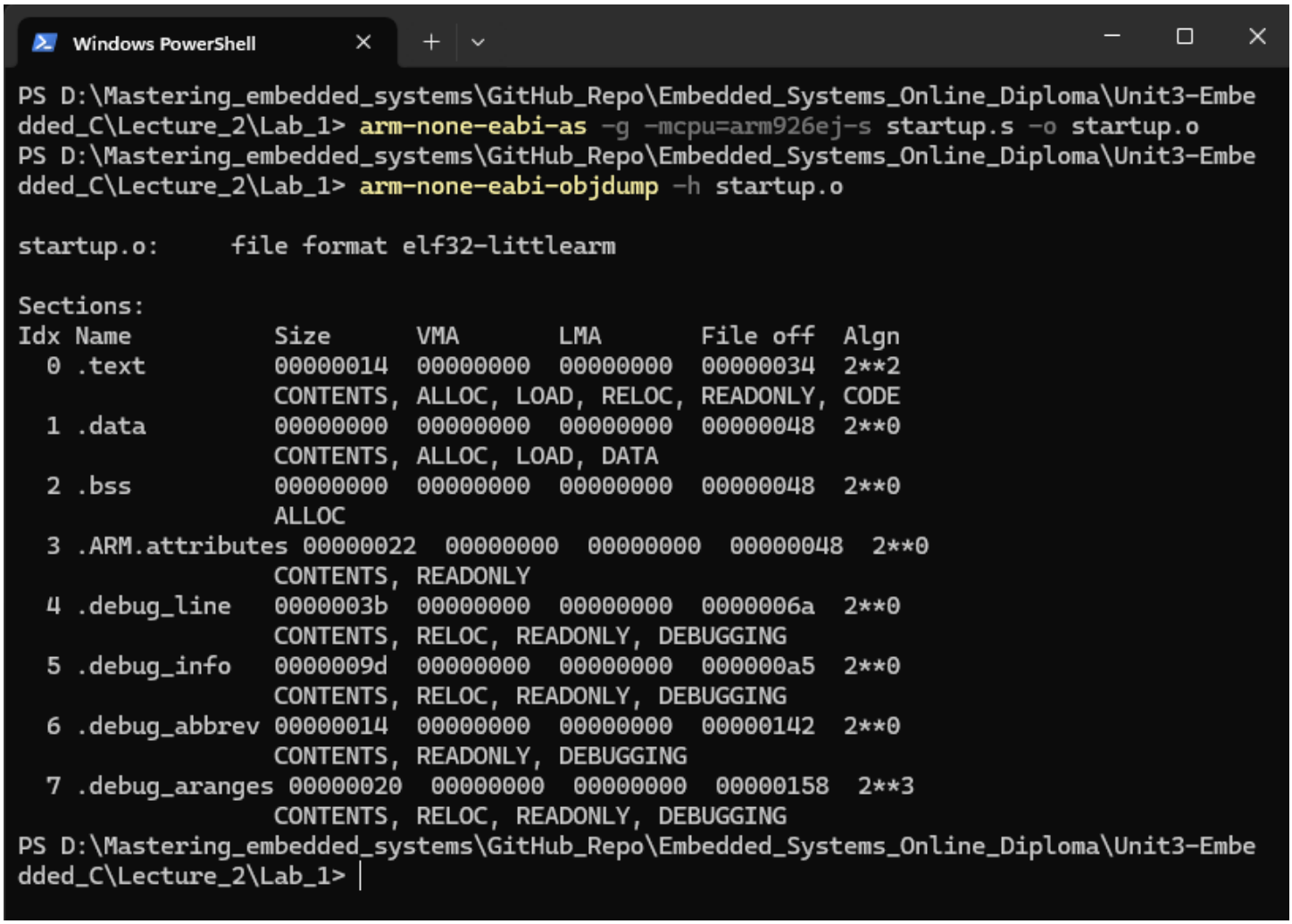
2.1: uart.o



2.2: app.o


Windows PowerShell
PS D:\Mastering_embedded_systems\GitHub_Repo\Embedded_Systems_Online_Diploma\Unit3-Embedded_C\Lecture_2\Lab_1> arm-none-eabi-gcc -c -g -I . -mcpu=arm926ej-s app.c -o app.o
PS D:\Mastering_embedded_systems\GitHub_Repo\Embedded_Systems_Online_Diploma\Unit3-Embedded_C\Lecture_2\Lab_1> arm-none-eabi-objdump -h app.o
app.o: file format elf32-littlearm
Sections:
Idx Name Size VMA LMA File off Algn
0 .text 00000018 00000000 00000000 00000034 2**2
CONTENTS, ALLOC, LOAD, RELOC, READONLY, CODE
1 .data 00000064 00000000 00000000 0000004c 2**2
CONTENTS, ALLOC, LOAD, DATA
2 .bss 00000000 00000000 00000000 000000b0 2**0
ALLOC
3 .debug_info 000000b6 00000000 00000000 000000b0 2**0
CONTENTS, RELOC, READONLY, DEBUGGING
4 .debug_abbrev 00000072 00000000 00000000 00000166 2**0
CONTENTS, READONLY, DEBUGGING
5 .debug_loc 0000002c 00000000 00000000 000001d8 2**0
CONTENTS, READONLY, DEBUGGING
6 .debug_aranges 00000020 00000000 00000000 00000204 2**0
CONTENTS, RELOC, READONLY, DEBUGGING
7 .debug_line 0000004b 00000000 00000000 00000224 2**0
CONTENTS, RELOC, READONLY, DEBUGGING
8 .debug_str 00000115 00000000 00000000 0000026f 2**0
CONTENTS, READONLY, DEBUGGING
9 .comment 00000012 00000000 00000000 00000384 2**0
CONTENTS, READONLY
10 .ARM.attributes 00000032 00000000 00000000 00000396 2**0
CONTENTS, READONLY
11 .debug_frame 0000002c 00000000 00000000 000003c8 2**2
CONTENTS, RELOC, READONLY, DEBUGGING
PS D:\Mastering_embedded_systems\GitHub_Repo\Embedded_Systems_Online_Diploma\Unit3-Embedded_C\Lecture_2\Lab_1>

2.3: startup.o


Windows PowerShell
PS D:\Mastering_embedded_systems\GitHub_Repo\Embedded_Systems_Online_Diploma\Unit3-Embedded_C\Lecture_2\Lab_1> arm-none-eabi-as -g -mcpu=arm926ej-s startup.s -o startup.o
PS D:\Mastering_embedded_systems\GitHub_Repo\Embedded_Systems_Online_Diploma\Unit3-Embedded_C\Lecture_2\Lab_1> arm-none-eabi-objdump -h startup.o
startup.o: file format elf32-littlearm
Sections:
Idx Name Size VMA LMA File off Algn
0 .text 00000014 00000000 00000000 00000034 2**2
CONTENTS, ALLOC, LOAD, RELOC, READONLY, CODE
1 .data 00000000 00000000 00000000 00000048 2**0
CONTENTS, ALLOC, LOAD, DATA
2 .bss 00000000 00000000 00000000 00000048 2**0
ALLOC
3 .ARM.attributes 00000022 00000000 00000000 00000048 2**0
CONTENTS, READONLY
4 .debug_line 0000003b 00000000 00000000 0000006a 2**0
CONTENTS, RELOC, READONLY, DEBUGGING
5 .debug_info 0000009d 00000000 00000000 000000a5 2**0
CONTENTS, RELOC, READONLY, DEBUGGING
6 .debug_abbrev 00000014 00000000 00000000 00000142 2**0
CONTENTS, READONLY, DEBUGGING
7 .debug_aranges 00000020 00000000 00000000 00000158 2**3
CONTENTS, RELOC, READONLY, DEBUGGING
PS D:\Mastering_embedded_systems\GitHub_Repo\Embedded_Systems_Online_Diploma\Unit3-Embedded_C\Lecture_2\Lab_1>

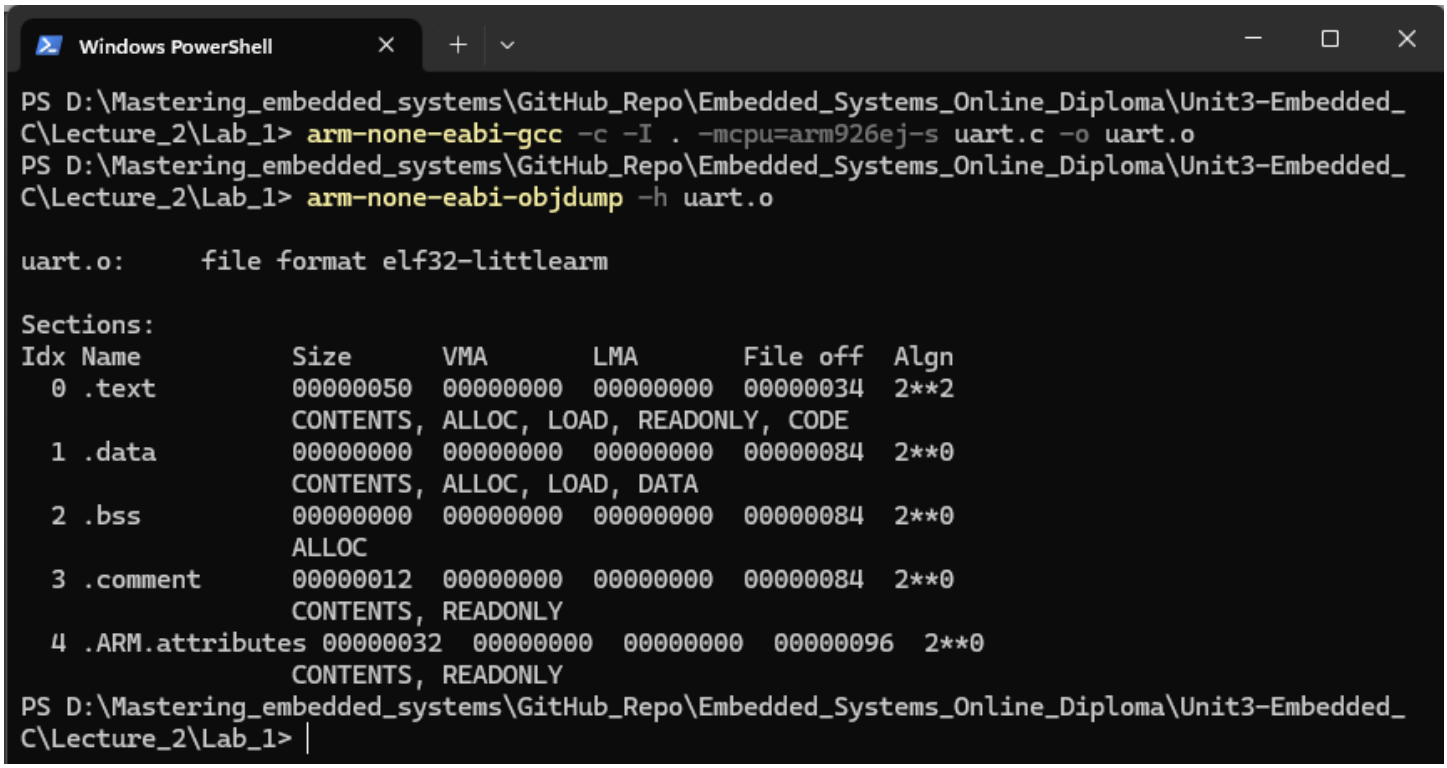
2.4: lab_1.elf Sections

Windows PowerShell

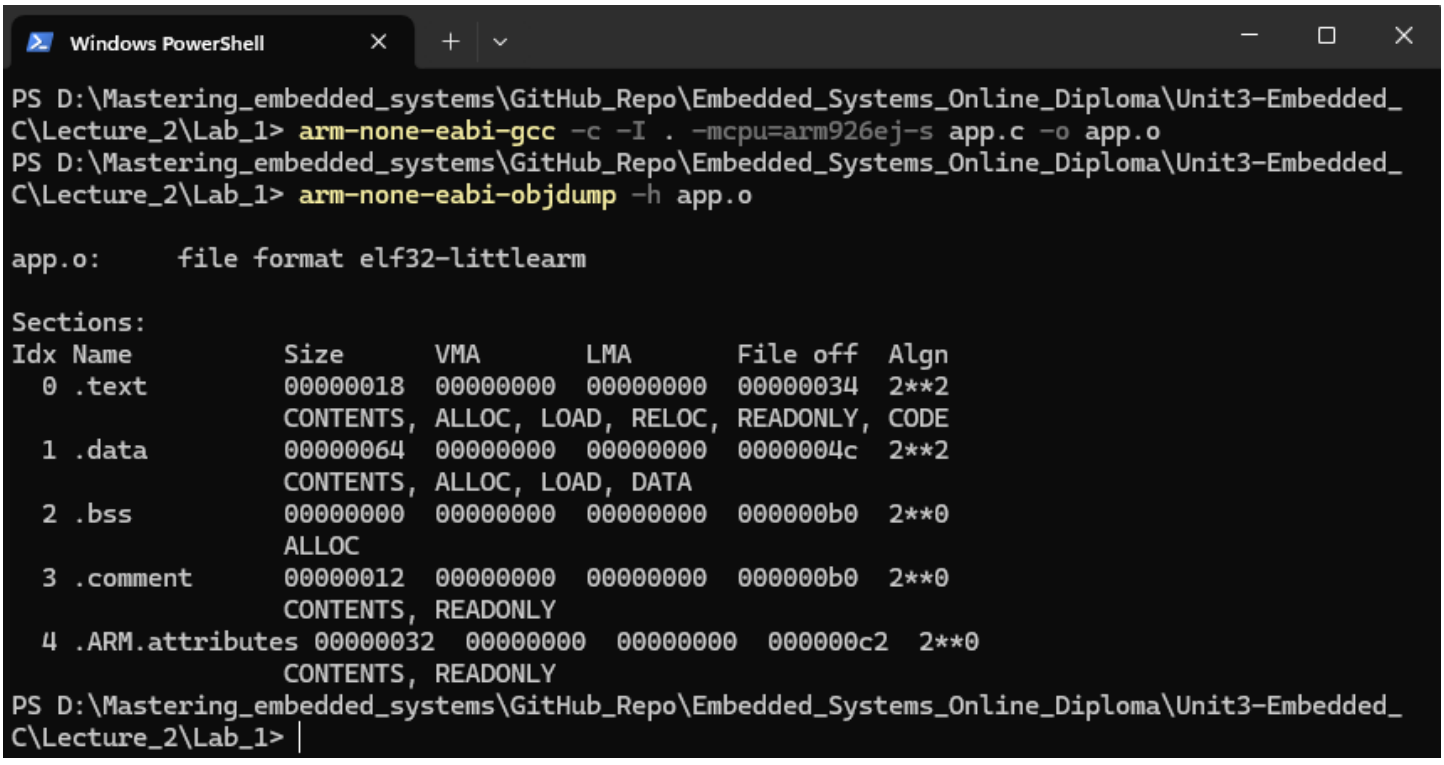
```
PS D:\Mastering_embedded_systems\GitHub_Repo\Embedded_Systems_Online_Diploma\Unit3-Embedded_
C\Lecture_2\Lab_1> arm-none-eabi-ld -T linker_script.ld startup.o app.o uart.o -o lab_1.elf
PS D:\Mastering_embedded_systems\GitHub_Repo\Embedded_Systems_Online_Diploma\Unit3-Embedded_
C\Lecture_2\Lab_1> arm-none-eabi-objdump -h lab_1.elf

lab_1.elf:     file format elf32-littlearm

Sections:
Idx Name          Size      VMA       LMA       File off  Algn
  0 .startup      00000010  00010000  00010000  00008000  2**2
                  CONTENTS, ALLOC, LOAD, READONLY, CODE
  1 .text         00000068  00010010  00010010  00008010  2**2
                  CONTENTS, ALLOC, LOAD, READONLY, CODE
  2 .data         00000064  00010078  00010078  00008078  2**2
                  CONTENTS, ALLOC, LOAD, DATA
  3 .ARM.attributes 0000002e  00000000  00000000  000080dc  2**0
                  CONTENTS, READONLY
  4 .comment      00000011  00000000  00000000  0000810a  2**0
                  CONTENTS, READONLY
  5 .debug_line   000000d8  00000000  00000000  0000811b  2**0
                  CONTENTS, READONLY, DEBUGGING
  6 .debug_info   00000214  00000000  00000000  000081f3  2**0
                  CONTENTS, READONLY, DEBUGGING
  7 .debug_abbrev 000000f6  00000000  00000000  00008407  2**0
                  CONTENTS, READONLY, DEBUGGING
  8 .debug_aranges 00000060  00000000  00000000  00008500  2**3
                  CONTENTS, READONLY, DEBUGGING
  9 .debug_loc    00000058  00000000  00000000  00008560  2**0
                  CONTENTS, READONLY, DEBUGGING
 10 .debug_str    0000012a  00000000  00000000  000085b8  2**0
                  CONTENTS, READONLY, DEBUGGING
 11 .debug_frame  00000054  00000000  00000000  000086e4  2**2
                  CONTENTS, READONLY, DEBUGGING
PS D:\Mastering_embedded_systems\GitHub_Repo\Embedded_Systems_Online_Diploma\Unit3-Embedded_
C\Lecture_2\Lab_1>
```

3. Object Files and Sections analyze without debug sections

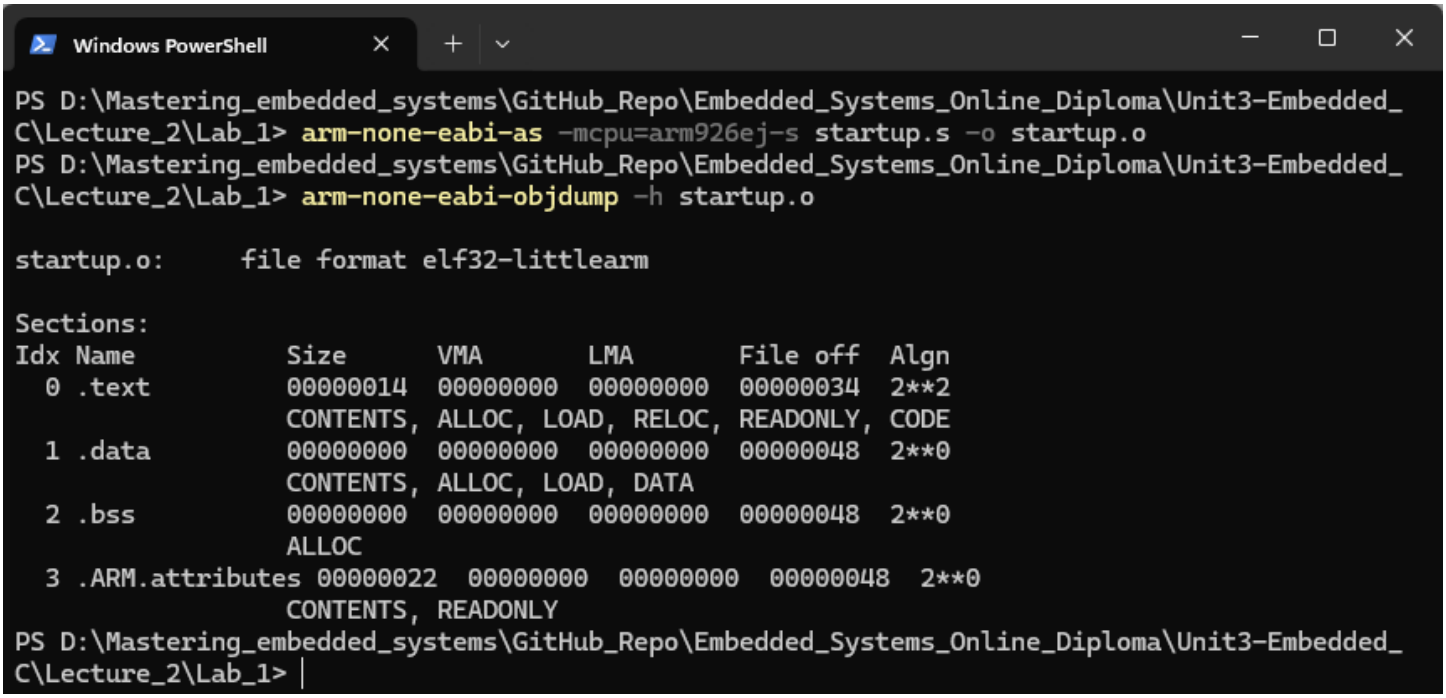
3.1: uart.o



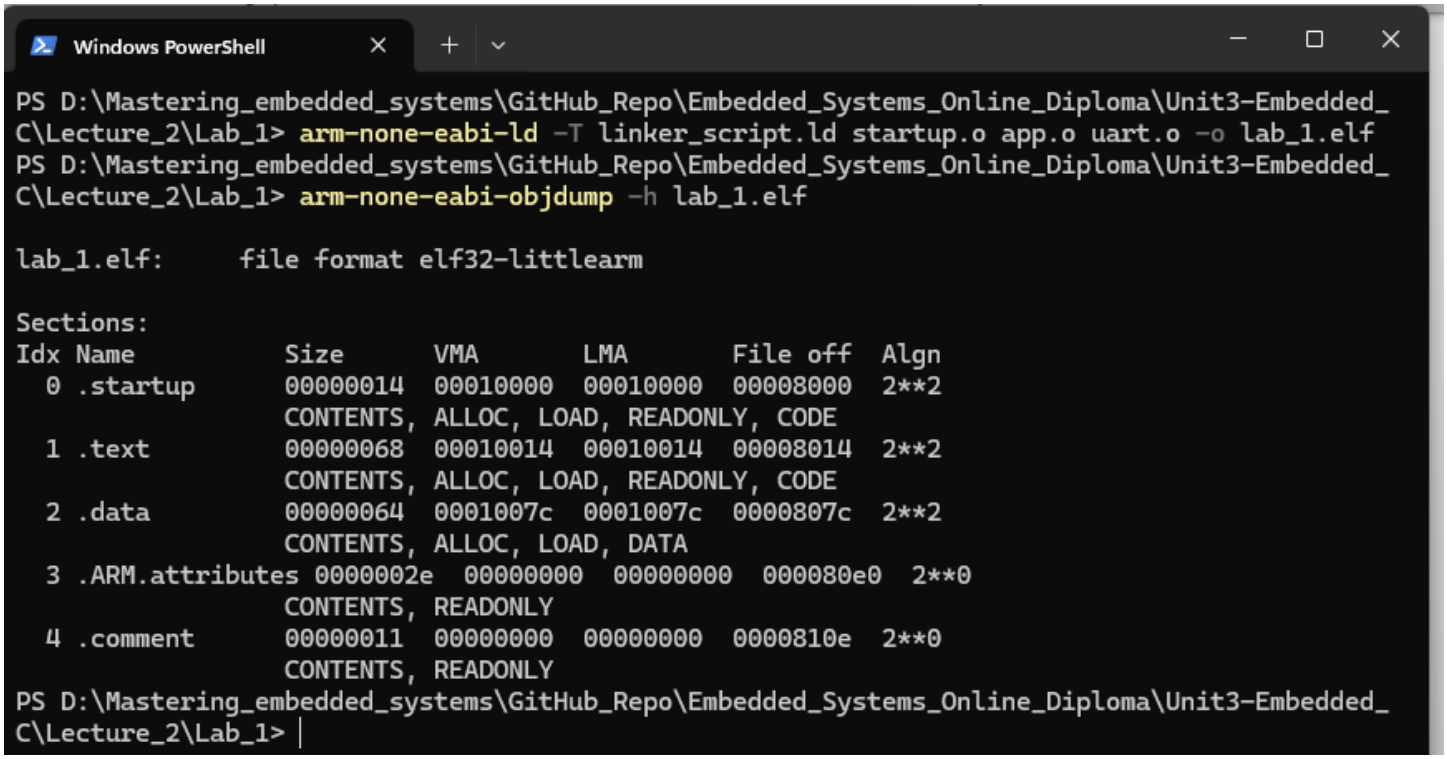
3.2: app.o



3.3: startup.o

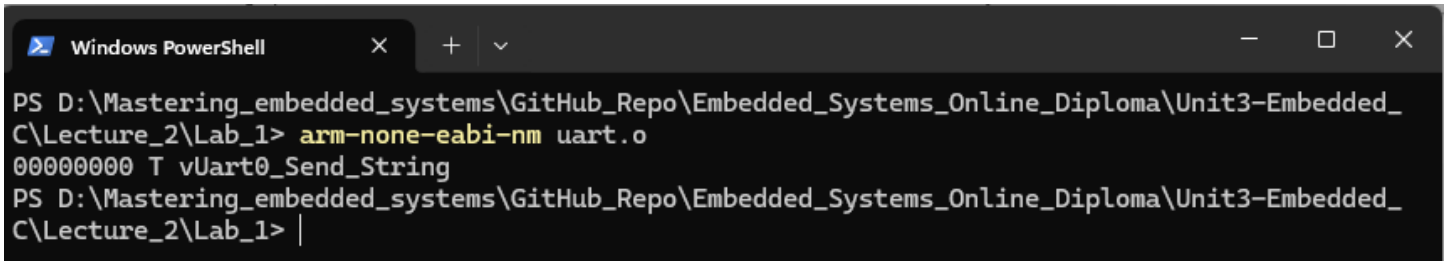


3.4: lab_1.elf Sections

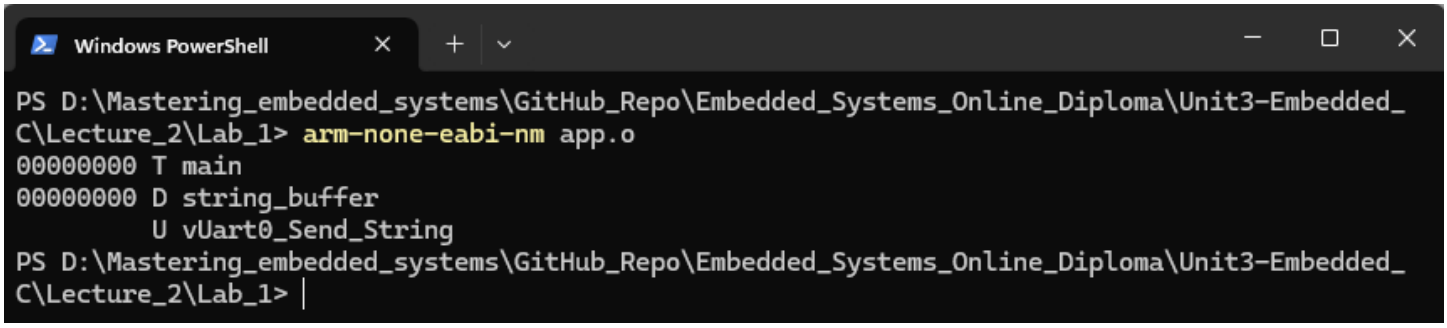


4. Symbols table

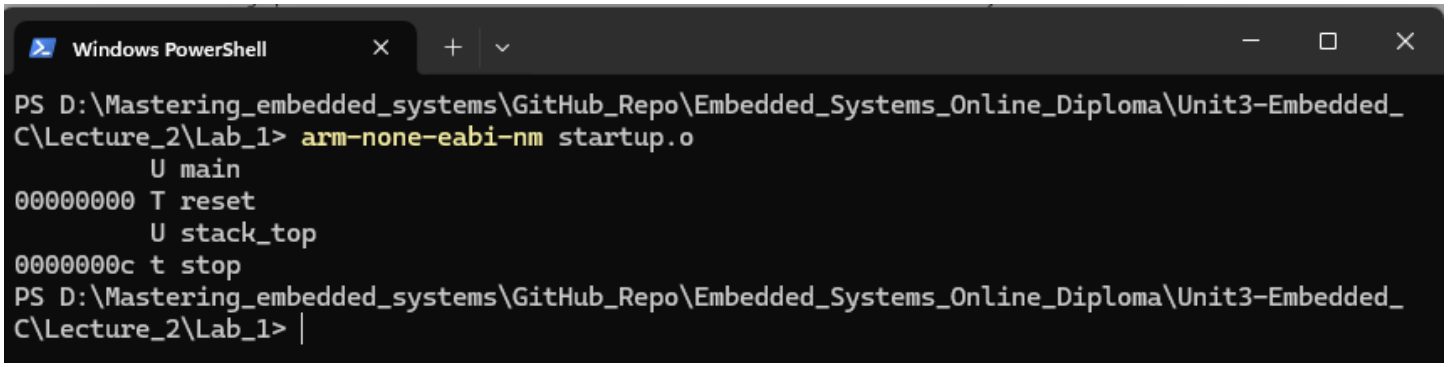
4.1: uart.o



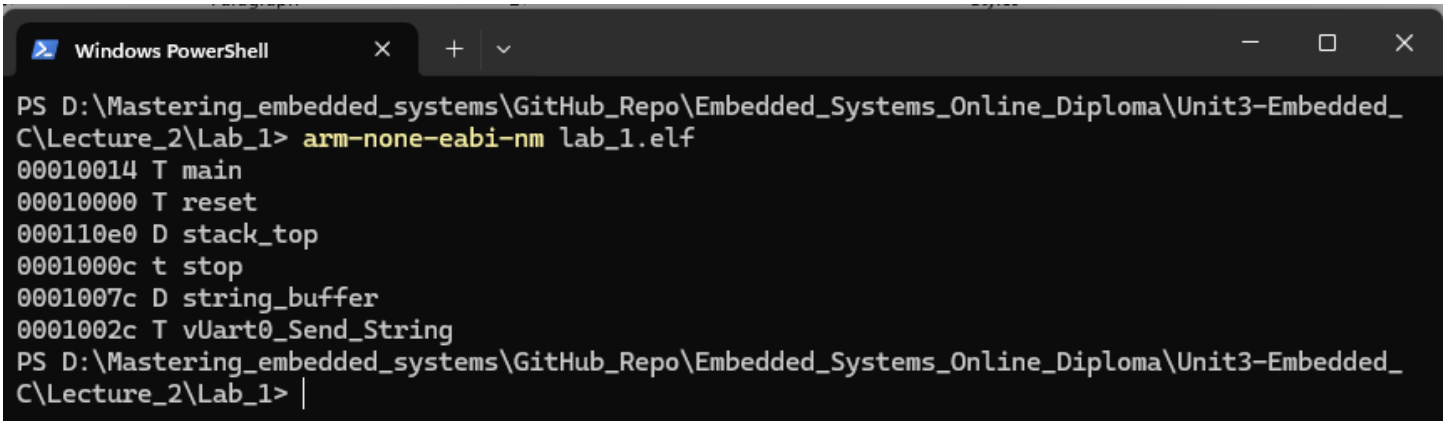
4.2: app.o



4.3: startup.o



4.4: lab_1.elf



5. readelf Binary Utilities

Windows PowerShell

```
PS D:\Mastering_embedded_systems\GitHub_Repo\Embedded_Systems_Online_Diploma\Unit3-Embedded_C
\Lecture_2\Lab_1> arm-none-eabi-readelf -a lab_1.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:               0x10000
  Start of program headers:          52 (bytes into file)
  Start of section headers:          33128 (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:         1
  Size of section headers:           40 (bytes)
  Number of section headers:         9
  Section header string table index: 6

Section Headers:
  [Nr] Name              Type            Addr     Off    Size   ES Flg Lk Inf Al
  [ 0]                   NULL            00000000 000000 000000 00      0   0  0
  [ 1] .startup          PROGBITS        00010000 008000 000014 00  AX  0   0  4
  [ 2] .text             PROGBITS        00010014 008014 000068 00  AX  0   0  4
  [ 3] .data             PROGBITS        0001007c 00807c 000064 00  WA  0   0  4
  [ 4] .ARM.attributes   ARM_ATTRIBUTES  00000000 0080e0 00002e 00      0   0  1
  [ 5] .comment          PROGBITS        00000000 00810e 000011 01  MS  0   0  1
  [ 6] .shstrtab         STRTAB          00000000 00811f 000049 00      0   0  1
  [ 7] .symtab           SYMTAB          00000000 0082d0 000170 10      8  18  4
  [ 8] .strtab           STRTAB          00000000 008440 000059 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 0x00010000 0x00010000 0x000e0 0x000e0 RWE 0x8000

 Section to Segment mapping:
  Segment Sections...
   00     .startup .text .data

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 23 entries:
   Num:    Value  Size Type    Bind   Vis      Ndx Name
     0: 00000000     0 NOTYPE  LOCAL  DEFAULT  UND
     1: 00010000     0 SECTION LOCAL  DEFAULT    1
     2: 00010014     0 SECTION LOCAL  DEFAULT    2
     3: 0001007c     0 SECTION LOCAL  DEFAULT    3
     4: 00000000     0 SECTION LOCAL  DEFAULT    4
     5: 00000000     0 SECTION LOCAL  DEFAULT    5
     6: 00000000     0 FILE    LOCAL  DEFAULT  ABS startup.o
     7: 00010000     0 NOTYPE  LOCAL  DEFAULT    1 $a
     8: 0001000c     0 NOTYPE  LOCAL  DEFAULT    1 stop
     9: 00010010     0 NOTYPE  LOCAL  DEFAULT    1 $d
    10: 00000000     0 FILE    LOCAL  DEFAULT  ABS app.c
    11: 0001007c     0 NOTYPE  LOCAL  DEFAULT    3 $d
    12: 00010014     0 NOTYPE  LOCAL  DEFAULT    2 $a
    13: 00010028     0 NOTYPE  LOCAL  DEFAULT    2 $d
    14: 00000000     0 FILE    LOCAL  DEFAULT  ABS uart.c
    15: 0001002c     0 NOTYPE  LOCAL  DEFAULT    2 $a
    16: 00010078     0 NOTYPE  LOCAL  DEFAULT    2 $d
    17: 00000000     0 FILE    LOCAL  DEFAULT  ABS
    18: 00010000     0 NOTYPE  GLOBAL DEFAULT    1 reset
    19: 000110e0     0 NOTYPE  GLOBAL DEFAULT    3 stack_top
    20: 00010014    24 FUNC    GLOBAL DEFAULT    2 main
    21: 0001007c   100 OBJECT  GLOBAL DEFAULT    3 string_buffer
    22: 0001002c    80 FUNC    GLOBAL DEFAULT    2 vUart0_Send_String

No version information found in this file.
Attribute Section: aeabi
File Attributes
  Tag_CPU_name: "ARM926EJ-S"
  Tag_CPU_arch: v5TEJ
  Tag_ARM_ISA_use: Yes
  Tag_THUMB_ISA_use: Thumb-1
  Tag_ABI_PCS_wchar_t: 4
  Tag_ABI_FP_denormal: Needed
  Tag_ABI_FP_exceptions: Needed
  Tag_ABI_FP_number_model: IEEE 754
  Tag_ABI_align_needed: 8-byte
  Tag_ABI_enum_size: small
PS D:\Mastering_embedded_systems\GitHub_Repo\Embedded_Systems_Online_Diploma\Unit3-Embedded_C
\Lecture_2\Lab_1>
```

6. Map file

```
Windows PowerShell
PS D:\Mastering_embedded_systems\GitHub_Repo\Embedded_Systems_Online_Diploma\Unit3-Embedded_C\Lecture_2\Lab_1> arm-none-eabi-ld -T linker_script.ld startup.o app.o uart.o -o lab_1.elf  -M >lab_1_Map.map
PS D:\Mastering_embedded_systems\GitHub_Repo\Embedded_Systems_Online_Diploma\Unit3-Embedded_C\Lecture_2\Lab_1>
```

D:\Mastering_embedded_systems\GitHub_Repo\Embedded_Systems_Online_Diploma\...

File Edit Selection Find View Goto Tools Project Preferences Help

uart.c | app.c | uart.h | startup.s | linker_script.ld | lab_1_Map.map

```
Memory Configuration

Name             Origin             Length             Attributes
Mem              0x00000000         0x04000000         xrw
*default*        0x00000000         0xffffffff

Linker script and memory map

                 0x00010000                 . = 0x10000

.startup         0x00010000       0x14
 startup.o(.text)
 .text           0x00010000       0x14 startup.o
                 0x00010000                 reset

.text            0x00010014       0x68
 *(.text)
 .text           0x00010014       0x18 app.o
                 0x00010014                 main
 .text           0x0001002c       0x50 uart.o
                 0x0001002c                 vUart0_Send_String
 *(.rodata)

.glue_7          0x0001007c        0x0
 .glue_7         0x00000000        0x0 linker stubs

.glue_7t         0x0001007c        0x0
 .glue_7t        0x00000000        0x0 linker stubs

.vfp11_veneer    0x0001007c        0x0
 .vfp11_veneer   0x00000000        0x0 linker stubs

.v4_bx           0x0001007c        0x0
 .v4_bx          0x00000000        0x0 linker stubs

.iplt            0x0001007c        0x0
 .iplt           0x00000000        0x0 startup.o

.rel.dyn         0x0001007c        0x0
 .rel.iplt       0x00000000        0x0 startup.o

.data            0x0001007c       0x64
 *(.data)
 .data           0x0001007c        0x0 startup.o
 .data           0x0001007c       0x64 app.o
                 0x0001007c                 string_buffer
 .data           0x000100e0        0x0 uart.o

.igot.plt        0x000100e0        0x0
 .igot.plt       0x00000000        0x0 startup.o

.bss             0x000100e0        0x0
 *(.bss)
 .bss            0x000100e0        0x0 startup.o
 .bss            0x000100e0        0x0 app.o
 .bss            0x000100e0        0x0 uart.o
 *(COMMON)
                 0x000110e0                 . = (. + 0x1000)
                 0x000110e0                 stack_top = .
LOAD startup.o
LOAD app.o
LOAD uart.o
OUTPUT(lab_1.elf elf32-littlearm)

.ARM.attributes
                 0x00000000       0x2e
 .ARM.attributes
                 0x00000000       0x22 startup.o
 .ARM.attributes
                 0x00000022       0x32 app.o
```

Line 39, Column 1 | main 15 | Spaces: 4 | Plain Text

7. Extract binary code and run program