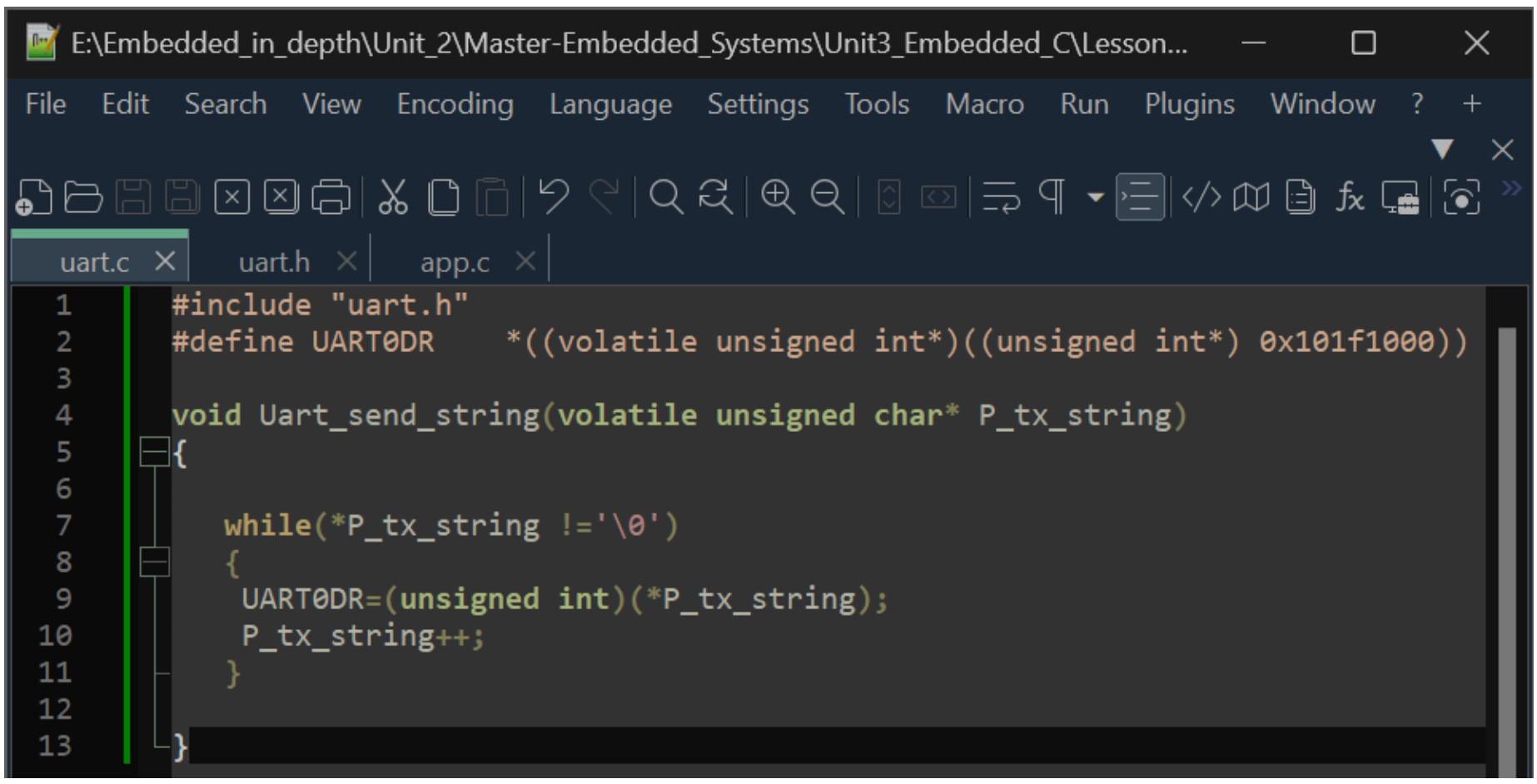
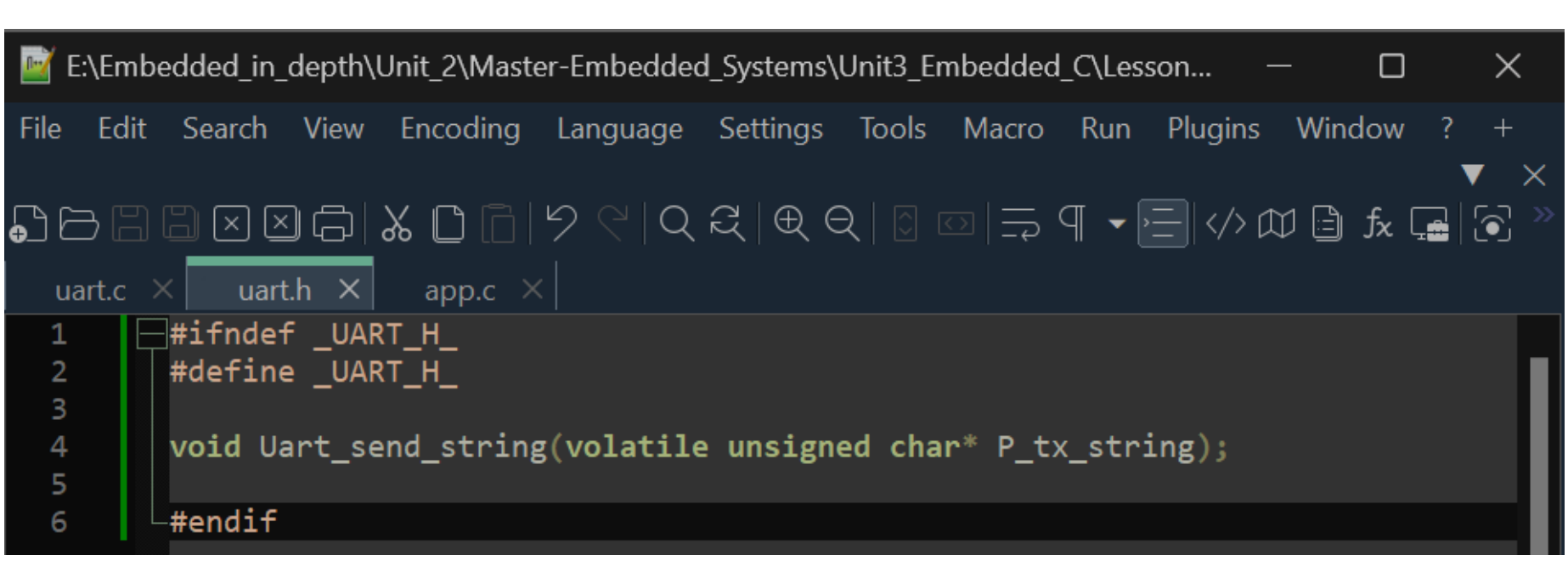
U3_Lab1_Report

lab1: create a BareMetal software to send "learn-in-depth: Shaimaa-Khattab" using UART.

uart.c



uart.h



app.c

E:\Embedded_in_depth\Unit_2\Master-Embedded_Systems\Unit3_Embedded_C\Lesson...

File Edit Search View Encoding Language Settings Tools Macro Run Plugins Window ? +

uart.c | uart.h | app.c

```c
#include "uart.h"
unsigned char string_buffer[100]="learn-in-depth:Shaimaa-Khattab";
unsigned char const string_buffer2[100]="learn-in-depth:Shaimaa-Khattab";


void main(void)
{
    Uart_send_string(string_buffer);
}
```

Generate (uart/app).o objects files

MINGW64:/e/Embedded_in_depth/Unit_2/Master-Embedded_Systems/Unit3_Embedded_C/Lesson2_Assignment

```
Shima@Naruto MINGW64 /e/Embedded_in_depth/Unit_2/Master-Embedded_Systems/Unit3_E
mbedded_C/Lesson2_Assignment (master)
$ arm-none-eabi-gcc.exe -c -g -mcpu=arm926ej-s -I . App.c -o App.o

Shima@Naruto MINGW64 /e/Embedded_in_depth/Unit_2/Master-Embedded_Systems/Unit3_E
mbedded_C/Lesson2_Assignment (master)
$ arm-none-eabi-gcc.exe -c -g -I . -mcpu=arm926ej-s uart.c -o uart.o

Shima@Naruto MINGW64 /e/Embedded_in_depth/Unit_2/Master-Embedded_Systems/Unit3_E
mbedded_C/Lesson2_Assignment (master)
$ ls *.o
App.o  uart.o

Shima@Naruto MINGW64 /e/Embedded_in_depth/Unit_2/Master-Embedded_Systems/Unit3_E
mbedded_C/Lesson2_Assignment (master)
$
```

Using ARM-Cross toolchain Bin Utilities (objdump)

MINGW64:/e/Embedded_in_depth/Unit_2/Master-Embedded_Systems/Unit3_Embedded_C/Lesson2_Assignment

```
Shima@Naruto MINGW64 /e/Embedded_in_depth/Unit_2/Master-Embedded_Systems/Unit3_Embed
ded_C/Lesson2_Assignment (master)
$ arm-none-eabi-objdump.exe --help
Usage: E:\Embedded_in_depth\7 2017-q4-major\bin\arm-none-eabi-objdump.exe <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
  -S, --source             Intermix source code with disassembly
  -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
```

app.o sections

MINGW64:/e/Embedded_in_depth/Unit_2/Master-Embedded_Systems/Unit3_Embedde...

```
Shima@Naruto MINGW64 /e/Embedded_in_depth/Unit_2/Master-Embedded_Systems/Unit3_Embed
$ arm-none-eabi-objdump.exe -h app.o

app.o:     file format elf32-littlearm

Sections:
Idx Name          Size      VMA       LMA       File off  Algn
  0 .text         0000001c  00000000  00000000  00000034  2**2
                  CONTENTS, ALLOC, LOAD, RELOC, READONLY, CODE
  1 .data         00000064  00000000  00000000  00000050  2**2
                  CONTENTS, ALLOC, LOAD, DATA
  2 .bss          00000000  00000000  00000000  000000b4  2**0
                  ALLOC
  3 .rodata       00000064  00000000  00000000  000000b4  2**2
                  CONTENTS, ALLOC, LOAD, READONLY, DATA
  4 .debug_info   00000091  00000000  00000000  00000118  2**0
                  CONTENTS, RELOC, READONLY, DEBUGGING
  5 .debug_abbrev 00000061  00000000  00000000  000001a9  2**0
                  CONTENTS, READONLY, DEBUGGING
  6 .debug_aranges 00000020  00000000  00000000  0000020a  2**0
                  CONTENTS, RELOC, READONLY, DEBUGGING
  7 .debug_line   00000035  00000000  00000000  0000022a  2**0
                  CONTENTS, RELOC, READONLY, DEBUGGING
  8 .debug_str    000000f8  00000000  00000000  0000025f  2**0
                  CONTENTS, READONLY, DEBUGGING
  9 .comment      0000007f  00000000  00000000  00000357  2**0
                  CONTENTS, READONLY
 10 .debug_frame  0000002c  00000000  00000000  000003d8  2**2
                  CONTENTS, RELOC, READONLY, DEBUGGING
 11 .ARM.attributes 00000032  00000000  00000000  00000404  2**0
                  CONTENTS, READONLY

Shima@Naruto MINGW64 /e/Embedded_in_depth/Unit_2/Master-Embedded_Systems/Unit3_Embed
ded_C/Lesson2_Assignment (master)
$
```

Generate the disassembly file from the bin

```
Shima@Naruto MINGW64 /e/Embedded_in_depth/Unit_2/Master-Embedded_Systems/Unit3_Embed
ded_C/Lesson2_Assignment (master)
$ arm-none-eabi-objdump.exe -D app.o > app.s

Shima@Naruto MINGW64 /e/Embedded_in_depth/Unit_2/Master-Embedded_Systems/Unit3_Embed
ded_C/Lesson2_Assignment (master)
$ arm-none-eabi-objdump.exe -s app.o

app.o:     file format elf32-littlearm

Contents of section .text:
 0000 00482de9 04b08de2 08009fe5 feffffeb  .H-.............
 0010 0000a0e1 0088bde8 00000000           ............
Contents of section .data:
 0000 6c656172 6e2d696e 2d646570 74683a53  learn-in-depth:S
 0010 6861696d 61612d4b 68617474 61620000  haimaa-Khattab..
 0020 00000000 00000000 00000000 00000000  ................
 0030 00000000 00000000 00000000 00000000  ................
 0040 00000000 00000000 00000000 00000000  ................
 0050 00000000 00000000 00000000 00000000  ................
 0060 00000000                             ....
Contents of section .rodata:
 0000 6c656172 6e2d696e 2d646570 74683a53  learn-in-depth:S
```

Display the full content of all sections requested

```
Shima@Naruto MINGW64 /e/Embedded_in_depth/Unit_2/Master-Embedded_Systems/Unit3_Embed
ded_C/Lesson2_Assignment (master)
$ arm-none-eabi-objdump.exe -D app.o > app.s

Shima@Naruto MINGW64 /e/Embedded_in_depth/Unit_2/Master-Embedded_Systems/Unit3_Embed
ded_C/Lesson2_Assignment (master)
$ arm-none-eabi-objdump.exe -s app.o

app.o:     file format elf32-littlearm

Contents of section .text:
 0000 00482de9 04b08de2 08009fe5 feffffeb  .H-.............
 0010 0000a0e1 0088bde8 00000000           ............
Contents of section .data:
 0000 6c656172 6e2d696e 2d646570 74683a53  learn-in-depth:S
 0010 6861696d 61612d4b 68617474 61620000  haimaa-Khattab..
 0020 00000000 00000000 00000000 00000000  ................
 0030 00000000 00000000 00000000 00000000  ................
 0040 00000000 00000000 00000000 00000000  ................
 0050 00000000 00000000 00000000 00000000  ................
 0060 00000000                             ....
Contents of section .rodata:
 0000 6c656172 6e2d696e 2d646570 74683a53  learn-in-depth:S
 0010 6861696d 61612d4b 68617474 61620000  haimaa-Khattab..
 0020 00000000 00000000 00000000 00000000  ................
 0030 00000000 00000000 00000000 00000000  ................
 0040 00000000 00000000 00000000 00000000  ................
 0050 00000000 00000000 00000000 00000000  ................
 0060 00000000                             ....
Contents of section .debug_info:
 0000 8d000000 04000000 00000401 31000000  ............1...
 0010 0c2b0000 009b0000 00000000 001c0000  .+..............
 0020 00000000 00023c00 00003500 00000335  ......<...5....5
 0030 00000063 00040407 8e000000 0401080f  ...c............
 0040 00000005 3c000000 061d0000 00010225  ....<..........%
 0050 00000005 03000000 00024300 00006900  ..........C...i.
 0060 00000335 00000063 00055900 00000600  ...5...c..Y.....
 0070 00000001 03690000 00050300 00000007  .....i..........
 0080 f3000000 01060000 00001c00 0000019c  ................
 0090 00                                   .
Contents of section .debug_abbrev:
 0000 01110125 0e130b03 0e1b0e11 01120610  ...%............
 0010 17000002 01014913 01130000 03210049  ......I......!.I
 0020 132f0b00 00042400 0b0b3e0b 030e0000  ./....$...>.....
 0030 05260049 13000006 3400030e 3a0b3b0b  .&.I....4...:.;.
 0040 49133f19 02180000 072e003f 19030e3a  I.?........?...:
```

Startup Code

E:\Embedded_in_depth\Unit_2\Master-Embedded_Systems\Unit3_Embedded_C\Lesson2_Assignment\startup.s - Notepad++

File Edit Search View Encoding Language Settings Tools Macro Run Plugins Window ?

uart.c | uart.h | app.c | startup.s

```
1  .globl reset
2  reset:
3  ldr sp, =0x00011000
4  bl main
5  stop: b  stop
6
```

Compile and Analyze it

MINGW64:/e/Embedded_in_depth/Unit_2/Master-Embedded_Systems/Unit3_Embedde...

```
Shima@Naruto MINGW64 /e/Embedded_in_depth/Unit_2/Master-Embedded_Systems/Unit3_Embed
ded_C/Lesson2_Assignment (master)
$ arm-none-eabi-as.exe -mcpu=arm926ej-s startup.s -o startup.o

Shima@Naruto MINGW64 /e/Embedded_in_depth/Unit_2/Master-Embedded_Systems/Unit3_Embed
ded_C/Lesson2_Assignment (master)
$ arm-none-eabi-objdump.exe -h startup.o

startup.o:     file format elf32-littlearm

Sections:
Idx Name          Size      VMA       LMA       File off  Algn
  0 .text         0000000c  00000000  00000000  00000034  2**2
                  CONTENTS, ALLOC, LOAD, RELOC, READONLY, CODE
  1 .data         00000000  00000000  00000000  00000040  2**0
                  CONTENTS, ALLOC, LOAD, DATA
  2 .bss          00000000  00000000  00000000  00000040  2**0
                  ALLOC
  3 .ARM.attributes 00000022  00000000  00000000  00000040  2**0
                  CONTENTS, READONLY

Shima@Naruto MINGW64 /e/Embedded_in_depth/Unit_2/Master-Embedded_Systems/Unit3_Embed
ded_C/Lesson2_Assignment (master)
$
```

Reading the symbols

MINGW64:/e/Embedded_in_depth/Unit_2/Master-Embedded_Systems/Unit3...

```
Shima@Naruto MINGW64 /e/Embedded_in_depth/Unit_2/Master-Embedded_Systems/Uni
t3_Embedded_C/Lesson2_Assignment (master)
$ arm-none-eabi-nm.exe app.o
00000000 T main
00000000 D string_buffer
00000000 R string_buffer2
         U Uart_send_string

Shima@Naruto MINGW64 /e/Embedded_in_depth/Unit_2/Master-Embedded_Systems/Uni
t3_Embedded_C/Lesson2_Assignment (master)
$ arm-none-eabi-nm.exe uart.o
00000000 T Uart_send_string

Shima@Naruto MINGW64 /e/Embedded_in_depth/Unit_2/Master-Embedded_Systems/Uni
t3_Embedded_C/Lesson2_Assignment (master)
$
```

executable file .elf

MINGW64:/e/Embedded_in_depth/Unit_2/Master-Embedded_Systems/Unit3_Embedde...

```
Shima@Naruto MINGW64 /e/Embedded_in_depth/Unit_2/Master-Embedded_Systems/Unit3_Embed
ded_C/Lesson2_Assignment (master)
$ arm-none-eabi-ld.exe -T Linker_Script.ld startup.o app.o uart.o -o learn-in-depth.
elf -MAP=Map_file.map

Memory Configuration

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

Linker script and memory map

                0x00010000                . = 0x10000

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

.text           0x0001000c       0x78
 *(.text)
 .text          0x0001000c       0x1c app.o
                0x0001000c                main
 .text          0x00010028       0x5c uart.o
                0x00010028                Uart_send_string

.rodata         0x00010084       0x64
 .rodata        0x00010084       0x64 app.o
                0x00010084                string_buffer2

.glue_7         0x000100e8        0x0
 .glue_7        0x000100e8        0x0 linker stubs

.glue_7t        0x000100e8        0x0
 .glue_7t       0x000100e8        0x0 linker stubs

.vfp11_veneer   0x000100e8        0x0
 .vfp11_veneer  0x000100e8        0x0 linker stubs

.v4_bx          0x000100e8        0x0
 .v4_bx         0x000100e8        0x0 linker stubs
```

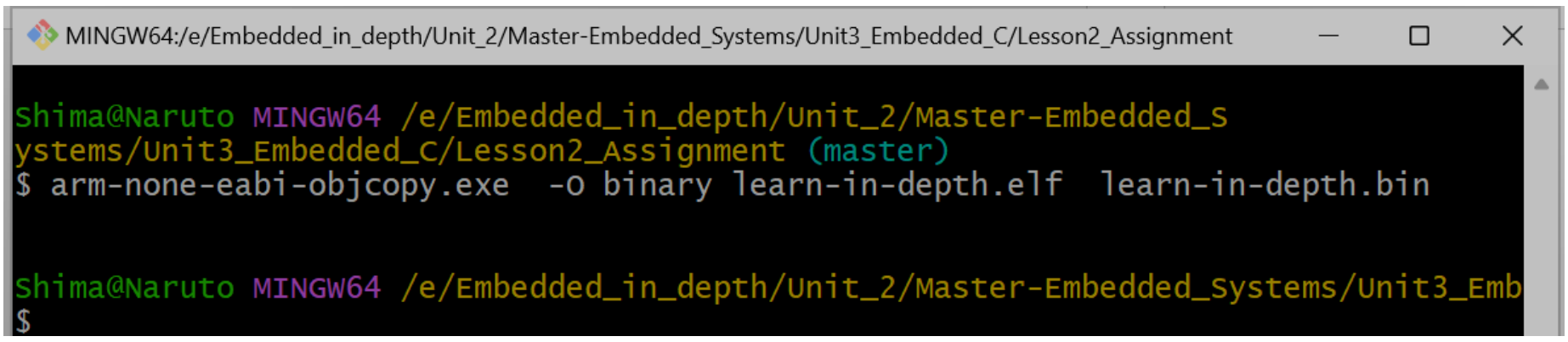
Symbols for learn-in-depth.elf

```
MINGW64:/e/Embedded_in_depth/Unit_2/Master-Embedded_Systems/Unit3_Embedde...

Shima@Naruto MINGW64 /e/Embedded_in_depth/Unit_2/Master-Embedded_Systems/Unit3_Embed
ded_C/Lesson2_Assignment (master)
$ arm-none-eabi-nm.exe learn-in-depth.elf
0001000c T main
00010000 T reset
0001114c D stack_top
00010008 t stop
000100e8 D string_buffer
00010084 R string_buffer2
00010028 T Uart_send_string

Shima@Naruto MINGW64 /e/Embedded_in_depth/Unit_2/Master-Embedded_Systems/Unit3_Embed
ded_C/Lesson2_Assignment (master)
$
```

Sections for learn-in-depth.elf

```
MINGW64:/e/Embedded_in_depth/Unit_2/Master-Embedded_Systems/Unit3_Embedde...

Shima@Naruto MINGW64 /e/Embedded_in_depth/Unit_2/Master-Embedded_S
ded_C/Lesson2_Assignment (master)
$ arm-none-eabi-objdump.exe -h  learn-in-depth.elf

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

Sections:
Idx Name          Size      VMA       LMA       File off  Algn
  0 .startup      0000000c  00010000  00010000  00010000  2**2
                  CONTENTS, ALLOC, LOAD, READONLY, CODE
  1 .text         00000078  0001000c  0001000c  0001000c  2**2
                  CONTENTS, ALLOC, LOAD, READONLY, CODE
  2 .rodata       00000064  00010084  00010084  00010084  2**2
                  CONTENTS, ALLOC, LOAD, READONLY, DATA
  3 .data         00000064  000100e8  000100e8  000100e8  2**2
                  CONTENTS, ALLOC, LOAD, DATA
  4 .ARM.attributes 0000002e  00000000  00000000  0001014c  2**0
                  CONTENTS, READONLY
  5 .comment      0000007e  00000000  00000000  0001017a  2**0
                  CONTENTS, READONLY
  6 .debug_info   000000ed  00000000  00000000  000101f8  2**0
                  CONTENTS, READONLY, DEBUGGING
  7 .debug_abbrev 000000b9  00000000  00000000  000102e5  2**0
                  CONTENTS, READONLY, DEBUGGING
  8 .debug_aranges 00000040  00000000  00000000  0001039e  2**0
                  CONTENTS, READONLY, DEBUGGING
  9 .debug_line   0000006e  00000000  00000000  000103de  2**0
                  CONTENTS, READONLY, DEBUGGING
 10 .debug_str    0000011c  00000000  00000000  0001044c  2**0
                  CONTENTS, READONLY, DEBUGGING
 11 .debug_frame  0000005c  00000000  00000000  00010568  2**2
                  CONTENTS, READONLY, DEBUGGING

Shima@Naruto MINGW64 /e/Embedded_in_depth/Unit_2/Master-Embedded_S
```

Generate binary file



Running the program in the QEMU Simulator: