

AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING



Computer and Systems Engineering Department
Specialized Programs

Junior Electrical Engineering, Electronics and Communications Engineering
Junior Electrical Engineering, Computer and Systems Engineering

Midterm - Spring 2022

Course Code: CSE 211

Time allowed: 1 Hr.

Introduction to Embedded Systems

The Exam Consists of 42 Questions in 6 Pages.

Maximum Marks: 42 Marks

1 / 6

تعليمات هامة

حذف التليفون المحمول مفتوحا داخل لجنة الامتحان يعتبر حالة غير مستوجب العقاب وإذا كان ضروري الدخول بالموibile فيوضع مغلق في الحقائب.

لا يسمح بدخول سماعة الأذن أو البلوتوث.

لا يسمح بدخول أي كتب أو ملازم أو أوراق داخل اللجنة والمخالفة تعتبر حالة غير.

For each of the following multiple-choice questions, select ONLY the ONE correct answer. Mark your choice in the answer sheet.

1. How many general-purpose registers do the ARM Cortex-M processors have?

- | | | | |
|-------|-------|-------|-------|
| A) 10 | B) 11 | C) 13 | D) 15 |
|-------|-------|-------|-------|

2. What is the purpose of register R15 in the ARM Cortex-M processors?

- | | |
|--|---|
| A) R15 is used to store the return address | B) R15 is used to point to the next instruction to be fetched |
| C) R15 is a stack pointer | D) None of the previous |

3. What is the purpose of register R14 in the ARM Cortex-M processors?

- | | |
|--|---|
| A) R14 is used to store the return address | B) R14 is used to point to the next instruction to be fetched |
| C) R14 is a stack pointer | D) None of the previous |

4. Which bus(s) is(are) connected to the Instructions Flash ROM?

- | | | | |
|--------------|--------------|---------------|------------------------|
| A) ICode bus | B) DCode bus | C) System bus | D) Answers (A) and (B) |
|--------------|--------------|---------------|------------------------|

5. Which bus(s) is(are) connected to the Data RAM?

- | | | | |
|--------------|--------------|---------------|------------------------|
| A) ICode bus | B) DCode bus | C) System bus | D) Answers (A) and (B) |
|--------------|--------------|---------------|------------------------|

6. What is the purpose of the N flag in the PSR of Cortex-M processors?

- | | |
|---|---|
| A) The N flag is set after performing an N arithmetic operation | B) The N flag is set if the result of the operation is less than zero |
| C) The N flag is set if result of the operation is zero | D) None of the previous |

7. What is the purpose of the V flag in the PSR of Cortex-M processors?

- | | |
|---|---|
| A) The V flag is set after performing an N arithmetic operation | B) The V flag is set if the result of the operation is less than zero |
| C) The V flag is set if result of the operation is zero | D) None of the previous |

8. What is the size of the Flash ROM in the TM4C123 Microcontroller?

- | | | | |
|----------|----------|-----------|-----------|
| A) 32 KB | B) 64 KB | C) 128 KB | D) 256 KB |
|----------|----------|-----------|-----------|

9. Using half word aligned, each location in memory is

- | | | | |
|-----------|------------|------------|------------|
| A) 1 byte | B) 2 bytes | C) 4 bytes | D) 8 bytes |
|-----------|------------|------------|------------|

10. The operations of the stack should be performed ----- the allocated area.

- | | | | |
|-----------|------------|-----------------------|---------|
| A) inside | B) outside | C) inside and outside | D) None |
|-----------|------------|-----------------------|---------|

11. In stack,

- | | |
|--|--|
| A) the number of pushes should be more than number of pops | B) the number of pushes should be less than number of pops |
| C) the number of pushes should be equal to number of pops | D) None |

;Stack accesses push or pop should not be performed outside the allocated area

PROG1: Q12-Q16	
A	AREA READ_variables, DATA, READONLY
B	DCD 4
C	DCD 3
X	DCD 1
	AREA WRITE_variables, DATA, READWRITE
1	X DCD 0
	AREA MYCODE, CODE, READONLY
1	LDR R0, [R4]
2	LDR R4, =A
3	LDR R4, =B
4	LDR R1, [R4]
5	LDR R4, =C
6	LDR R2, [R4]
7	ADD R3, R0, R1
8	STR R3, [R4]
9	MUL R3, R3, R2
10	LDR R4, =X
11	END

initialization:

$$A = 4$$

$$B = 3$$

$$C = 1$$

$$X = 0$$

Note: Line order is not correct in the above program.

12. In PROG1, what is the correct order for the above program to calculate $X=(A+B) \times C$?

A) 3-1-2-4-7-5-6-9-10-8-11	B) 2-1-3-4-7-5-6-9-8-10-11
C) 4-2-1-9-5-6-7-8-10	D) 3-2-4-1-7-5-6-9-8-10

```

LDR R4, =B
LDR R0, [R4]      ;R0 = B
LDR R4, =A
LDR R1, [R4]      ;R1 = A
ADD R3, R0, R1    ;R3 = A+B
LDR R4, =C
LDR R2, [R4]      ;R2 = C
MUL R3, R3, R2    ;R3 = C * (A+B)
LDR R4, =X
STR R3, [R4]      ;X = C * (A+B)

END

```

13. In PROG1, what is the value of R0 at the end of the program based on the selected order in Q12?

A) 0	B) 1	C) 2	D) 3
------	------	------	------

; R0 = B which's equal to 3

14. In PROG1, what is the value of R1 at the end of the program based on the selected order in Q12?

A) 0	B) 2	C) 4	D) 3
------	------	------	------

; R1 = A which's equal to 4

15. In PROG1, what is the addressing mode of "LDR R0, [R4]"?

A) Indexed addressing mode	B) PC-Relative addressing mode
C) Immediate addressing mode	D) None

16. In PROG1, what does "A DCD 4" mean?

A) Allocate 4-word locations in the memory	B) Allocate one word location with value "4"
C) Allocate uninitialized 4 bytes in the memory	D) None

17. Stack is a form of,

A) Last In First Out (LIFO)	B) First In First Out (FIFO)	C) Both A and B	D) None
-----------------------------	------------------------------	-----------------	---------

18. If the initial register contents of R0, R1 and R2 were R0= 0x00000000, R1= 0x02040608, R2= 0x10305070. After one of the operations below was performed on R1 and R2, R0 would be modified to 0x12345678 (R0 = 0x12345678).

What was the operation performed on the contents of R2 and R1?

A) AND	B) ORR	C) BIC	D) MUL
--------	--------	--------	--------

$$\begin{array}{r} \text{ox}02040608 \\ \downarrow \downarrow \downarrow \downarrow \downarrow \\ \text{ox}10305070 \\ \hline = \text{ox}12345678 \end{array}$$

: Certain bit Zero = the same bit
 must be
ORR

19. Status of Z flag after the execution of CMP instruction on R0 and R9 is ---- when R0 = 12 and R9 = 12.

A) Z=1	B) Z=0	C) Same as previous value	D) None
--------	--------	---------------------------	---------

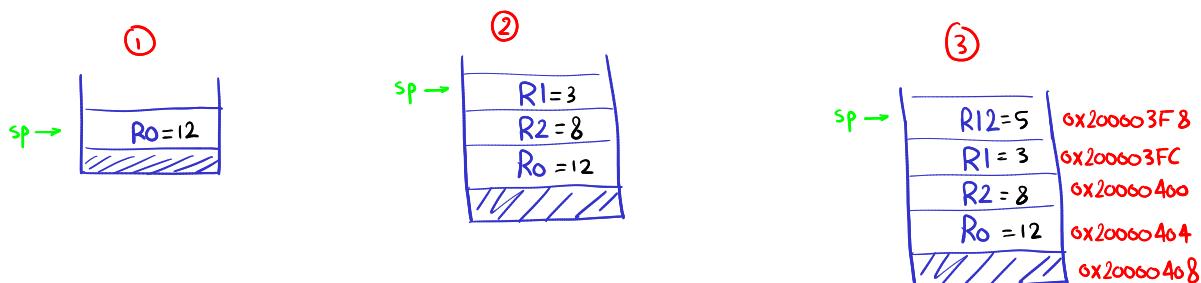
; $R0 - R9 = 12 - 12 = 0$

* when the result of CMP instruction is equal to Zero, the Z flag is set ($Z = 1$)

20. Assume the stack pointer (SP) is initialized to 0x20000408. Registers R0, R1, R2 and R12 are initialized to 12, 3, 8 and 5 respectively. What is the content of the stack (from top of stack to bottom) after the following sequence of operations?

- ① PUSH {R0}
- ② PUSH {R1-R2}
- ③ PUSH {R12}

A) 12, 3, 8, 5	B) 5, 3, 8, 12	C) 5, 8, 3, 12	D) None
----------------	----------------	----------------	---------

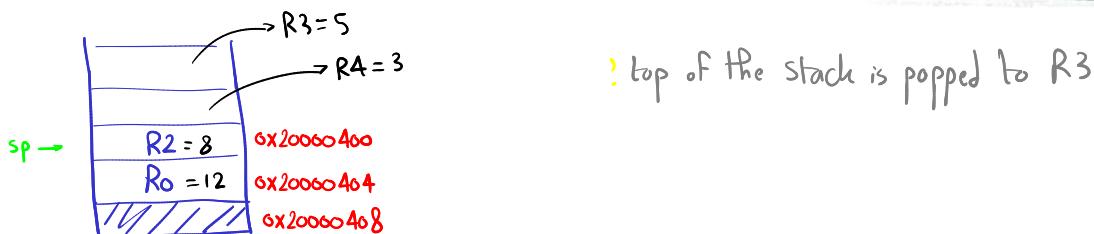


21. What is the stack pointer value after the operations done in Q20?

A) 0x200003F8	B) 0x200003FC	C) 0x20000400	D) None
---------------	---------------	---------------	---------

22. Based on the state of the stack after executing the operations in Q20, what are the contents of R3 and R4 after the POP {R3-R4} operation?

A) R3=5, R4=3	B) R3= 12, R4=3	C) R3=3, R4=5	D) None
---------------	-----------------	---------------	---------

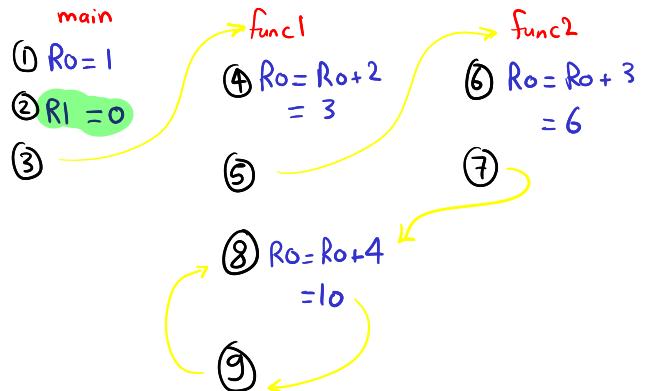


23. What is the stack pointer value after the operation done in Q22?

A) 0x200003F8	B) 0x200003FC	C) 0x20000400	D) None
---------------	---------------	---------------	---------

PROG2: Q24	
① MOV R0, #1	
② MOV R1, #0	
③ BL func1	
ADD R1, R0, #4	→ LR Save this address
loop	B loop
func1	
④ ADD R0, R0, #2	
⑤ BL func2	
⑥ ADD R0, R0, #4	→ LR overwrites on the save address it saved the address of this instruction
func2	
⑦ ADD R0, R0, #3	
⑧ BX LR	

;Error: the code missed preserving the link register of the main function
;So, instruction *ADD R1,R0,#4* won't be executed.

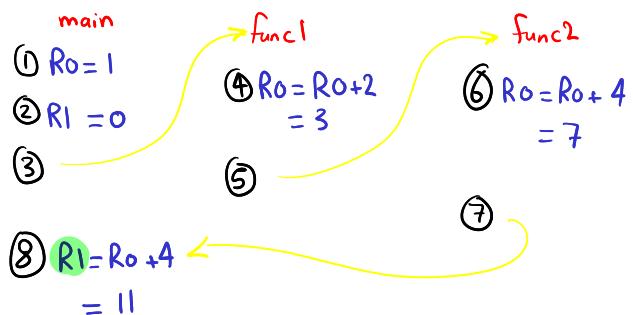


24. In PROG2, what is the value of R1 after running this code?

- | | | | |
|-------|------|------|-------|
| A) 10 | B) 5 | C) 0 | D) 14 |
|-------|------|------|-------|

PROG3: Q25-Q26	
MOV R0, #1	
MOV R1, #0	
BL func1	
ADD R1, R0, #4	
B Loop	
Loop	
func1	
ADD R0, R0, #2	
B func2	
ADD R0, R0, #4	
BX LR	
func2	
ADD R0, R0, #4	
BX LR	

;B instruction doesn't preserve the address so, the following instruction wont be executed
;as the LR has the address of instruction placed in the main function.



25. In PROG3, what is the value of R1 after running this code?

- | | | | |
|-------|-------|------|-------|
| A) 10 | B) 11 | C) 0 | D) 14 |
|-------|-------|------|-------|

26. In PROG3, what is the addressing mode of "BL func1"?

- | | |
|------------------------------|--------------------------------|
| A) Indexed addressing mode | B) PC-Relative addressing mode |
| C) Immediate addressing mode | D) None |

PROG4: Q27-Q34

```

AREA  WRITE_variables, DATA, READWRITE
a    space 4 ;a is 4 bytes uninitialized data
b    space 4 ;b is 4 bytes uninitialized data
s_size equ 12 ;s_size = 12
s_b   space s_size ; Stack base address ;s_b is 12 bytes uninitialized data
AREA  MYCODE, CODE, READONLY
ldr  sp, =s_b      ; STEP 1
add  sp, #s_size   ; STEP 2
ldr  r0, =a        ; STEP 3
mov  r4, #2        ; STEP 4
str  r4, [r0]      ; STEP 5 → ;a = 2
ldr  r1, =b        ; STEP 6
mov  r4, #6        ; STEP 7 → ;b = 6
str  r4, [r1]      ; STEP 8
ldr  r2, [r0]      ; STEP 9 → ;r2 = a = 2
ldr  r3, [r1]      ; STEP 10 → ;r3 = b = 6
add  r2, #1        ; STEP 11 → ;r2 = r2 + 1 = 3
add  r3, #1        ; STEP 12 → ;r3 = r3 + 1 = 7
bl   func          ; STEP 13
b    stop           ; STEP 14

func
  push {r2-r3}     ; STEP 15 →
  ldr  r2, [r0]      ; STEP 16 → ;r2 = a = 2
  ldr  r3, [r1]      ; STEP 17 → ;r3 = b = 6
  str  r2, [r1]      ; STEP 18 → ;b = 2
  str  r3, [r0]      ; STEP 19 → ;a = 6
  pop  {r2-r3}     ; STEP 20 →
  bx   lr

stop
END

```

27. In PROG4, what is the value of **r2** at the end of the program?

- | | | | |
|------|------|------|------|
| A) 2 | B) 3 | C) 4 | D) 5 |
|------|------|------|------|

28. In PROG4, what is the value of **r3** at the end of the program?

- | | | | |
|------|------|------|------|
| A) 2 | B) 6 | C) 5 | D) 7 |
|------|------|------|------|

29. In PROG4, what is the content of variable **b** in memory before calling function **func**?

- | | | | |
|------|------|------|------|
| A) 3 | B) 2 | C) 5 | D) 6 |
|------|------|------|------|

30. In PROG4, what is the value of **r2** after calling function **func**?

- | | | | |
|------|------|------|------|
| A) 7 | B) 3 | C) 4 | D) 5 |
|------|------|------|------|

31. In PROG4, function **func** is used to

- | | |
|---|---|
| A) Swap the contents of registers r2 and r3 | B) Swap the contents of registers r0 and r1 |
| C) Swap the contents of variables a and b in memory | D) None of the previous |

32. In PROG4, what is the value of **SP** after **STEP-18**?

- | | | | |
|-----------------|------------------|-----------------|-----------------|
| A) s_b-8 | B) s_b+20 | C) s_b+4 | D) s_b+8 |
|-----------------|------------------|-----------------|-----------------|

33. In PROG4, what is the value of **SP** after **STEP-20**?

- | | | | |
|-----------------|------------------|-----------------|-----------------|
| A) s_b-8 | B) s_b+12 | C) s_b+4 | D) s_b+8 |
|-----------------|------------------|-----------------|-----------------|

34. In PROG4, "a space 4" means

- | | |
|--|--|
| A) Allocate 4 bytes for variable "a" in memory | B) Allocate one byte for variable a with value "4" in memory |
| C) Allocate 4-word locations in memory | D) None |

PROG5: Q35-Q38

```

X           AREA myConstData, CODE, READONLY
          DCD 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 → X is an array

N           AREA myVarData, DATA, READWRITE
          DCD 0 → ;N = 0

ARR_SIZE    EQU      10 ;ARR_SIZE = 10
          LDR R0, =X ; STEP 1 → R0 has the base address of X ( ;R0 = X[0])
          MOV R2, #0 ; STEP 2 → ;R2 = 0
          MOV R3, #ARR_SIZE ; STEP 3 → ;R3 = 10

L1          it's loop that's
          summing the
          array elements
          LDR R1, [R0], #offset ; STEP 4 → ;R1 = 1
          ADD R2, R2, R1 ; STEP 5 → ;R2 = R2 + R1 = 1
          SUBS R3, R3, #1 ; STEP 6 → ;R3 = R3 - 1 = 9
          BNE L1 ; STEP 7 → ; go to L1 if R3 != zero
          LDR R0, =N ; STEP 8 → ; at the end of the loop
          STR R2, [R0] ; STEP 9 → ;N = R2 = 55
          b dloop ; STEP 10 → =0x37
          END
  
```

;R0 = R0 + OFFSET
R0 is used as index of the array
so offset must be = 4

35. In PROG5, what is the expected immediate value that should replace the **offset** symbol?

- | | | | |
|------|------|------|------|
| A) 0 | B) 4 | C) 2 | D) 1 |
|------|------|------|------|

36. In PROG5, what is the value of variable N after the execution of **STEP-09** based on Q35?

- | | | | |
|---------|---------|---------|---------|
| A) 0x55 | B) 0x37 | C) 0x10 | D) 0x30 |
|---------|---------|---------|---------|

37. In PROG5, what is the value of r0 after the first execution of **STEP-04** (after first iteration)?

- | | | | |
|-------------------------------|---------|---------|---------|
| A) The same as previous value | B) R0+4 | C) R0+2 | D) R0+1 |
|-------------------------------|---------|---------|---------|

38. In PROG5, " ARR_SIZE EQU 10" means

- | | |
|--|--|
| A) Assign value 10 to symbol ARR_SIZE | B) Allocate 10 bytes for variable ARR_SIZE |
| C) Allocate 10 locations for variable ARR_SIZE | D) None |

PROG6: Q39-Q42	
t	AREA myDATA, DATA, READWRITE DCD 0XE
	AREA myConstData, CODE, READONLY
	① MOV R0, #1 ; STEP 1 → ;R0 = 1 ② MOV R1, #2 ; STEP 2 → ;R1 = 2 ③ PUSH {R0} ; STEP 3 ④ PUSH {R1} ; STEP 4 ⑤ BL sum2 ; STEP 5 ⑬ POP {R0} ; STEP 6 ⑭ POP {R1} ; STEP 7 ⑮ LDR R1, =t ; STEP 8 ⑯ STR R0, [R1] ; STEP 9 ;t = R0 = 2 STOP sum2 ; STEP 10
	 
	⑥ ;Missing Instruction ;STEP 11 → ;Nested Functions must preserve LR in the stack ⑦ ADD R0, R0, R1 ;STEP 12 → ;R0 = R0 + R1 = 3 ⑧ BL sum1 ;STEP 13 ⑪ POP {LR} ;STEP 14 ⑫ BX LR ;STEP 15 ;functions should have ;an equal no. of ;pushes & pops
sum1	⑨ ADD R0, R0, R1 ;STEP 16 → ;R0 = R0 + R1 = 5 ⑩ BX LR ;STEP 17
	END

39. In PROG6, what is the missing instruction in STEP-11 to make the code work correctly?

- | | |
|--------------|--------------|
| A) POP {LR} | B) PUSH {R0} |
| C) PUSH {LR} | D) None |

40. In PROG6, what is the result of R0 after executing STEP-17?

- | | | | |
|------|------|------|------|
| A) 5 | B) 4 | C) 2 | D) 6 |
|------|------|------|------|

41. In PROG6, what is the result of R0 after executing STEP-06?

- | | | | |
|------|------|------|------|
| A) 5 | B) 4 | C) 2 | D) 6 |
|------|------|------|------|

42. In PROG6, where is the result value of function sum1 is saved?

- | | | | |
|-------|-------|-----------------|---------|
| A) R1 | B) R0 | C) In the stack | D) None |
|-------|-------|-----------------|---------|

Juba