

# Midterm Lab Practical Exam (Concept Questions)

Due: Thu, 08 Oct 2020 18:29:53 (approximately 64 days ago)

[Score: 21 / 30 points possible]

Weight = 4.0

## Instructions

This is a two-hour exam that you are given four hours to complete. Please pay careful attention to the due date for this exam. Press any of the 'Save' buttons often to make sure your work is saved. (Please do not double-click or click-storm the 'Save' button. That will cause problems for you.) Each time you save, the due date shown above will be updated. The course staff will be watching out for any system or infrastructure problems that might interfere with your progress. If you encounter a system problem, send e-mail to your lab TA. We cannot repair global Internet problems, but it's good for us to know about them.

When you save your work, scan the page to look for **Red warning text** that tells you that you've made some kind of syntax error. In addition, most text boxes where you must enter an answer are given an **orange** background color until you fill in a response and press "Save".

This exam is open-notes, open-book, and open-simulator. Nevertheless, you should not use commercial web sites that are not affiliated with the course and especially do not look at web sites that solve problems for you. You should also not seek help for any of these problems from any other person---including the course staff. You may look at Piazza, but you may not ask questions there. You are expected to be able to solve all of these problems on your own.

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## Academic Honesty Statement [0 ... -30 points]

The course staff want to make this exam as low stress as possible. In return, we expect that you will not engage in any form of academic dishonesty. Nevertheless, we expect that some students will, and we will be watching out for this. If you have evidence indicating any student is not in full compliance with the statement below, you can let the course staff know, and we will give it our full attention.

**By typing my name, below, I hereby certify that the work on this exam is my own and that I have not received assistance from or given assistance to any other person or web site (other than the ECE 362 course web site) while completing it. I understand that if I fail to honor this agreement, I will fail the course and I will be recommended for expulsion from the university.**

Raghuram Selvaraj



## Assembly language programming and CPU instructions

All of the questions and problems on this exam pertain specifically to the STM32F091RCT6 microcontroller, which has an ARM Cortex-M0 CPU, and is to be programmed with the unified syntax assembly language you've used in homework exercises and lab experiments.

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### Q1 [1 point]

[1 point]

What is the 16-bit hexadecimal encoding of the following instruction? Write exactly four hexadecimal digits with no "0x" prefix.

**ldrh r5, [r1, r7]**

 

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## Q2 [1 point]

[1 point]

Consider the following assembly language program segment, where you do not know the initial values of the registers or flags. Using only information about the instructions you see here, is the conditional branch to "target" taken, not taken, or unknowable?

```
ldr    r1,=0xe208e05a
lsls   r0,r1,#28
movs   r0,#40
bcs    target
```

 

---

## Q3 [1 point]

[1 point]

Consider the following assembly language program segment. What value will exist in register R0 when execution reaches the BKPT instruction? Express your answer as an 8-digit hexadecimal number.

```
ldr    r0,=0x75fff7f8
ldr    r1,=0x6b243904
bics   r0,r1
bkpt
```

 

---

## Q4 [1 point]

[1 point]

Consider the following assembly language program segment, where you do not know the initial values of the registers or flags. Using only information about the instructions you see here, is the conditional branch to "target" taken, not taken, or unknowable?

```
ldr    r1,=0xe501f9cf
sbcs   r0,r1
```

```
movs r0,#0  
bhi target
```



---

## Q5 [1 point]

### [1 point]

Consider the following assembly language program segment. If the assembler assigns the address for label "abc" to the value shown in the comment, what address will it assign to the label "xyz"? Express your answer as an 8-digit hexadecimal number.

```
.data  
abc: // 0x20000d68  
.byte 0x94  
.word 0xbd74d8df  
.string "abc"  
.equ inflate, 16  
.space 5  
.byte 0x23  
.hword 0xe645  
xyz:
```



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## Q6 [1 point]

### [1 point]

What ARM Cortex-M0 instruction does the following 16-bit hexadecimal value represent? Be sure to list any immediate operand value as a decimal (base-10) quantity.

8294



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## Q7 [1 point]

### [1 point]

For the following assembly language program segment, what value will exist in register R0 when execution reaches the BKPT instruction? Express your answer as an 8-digit hexadecimal number.

(Note that many students think there is a syntax error here. There's no error. This is one of the things that don't work in the simulator though.)

```

    ldr    r0,things
    ldrb   r0,[r0,#5]
    bkpt
.align 4
things:
.word extra+1, extra+4, extra+7, extra+0, extra+2, extra+5, extra+3, extra+6
extra:
.byte 0x98, 0xb5, 0xab, 0x90, 0xac, 0x94, 0x9f, 0xbd
.byte 0xd0, 0xd7, 0xdd, 0xce, 0xde, 0xc7, 0xc8, 0xd5
.byte 0xef, 0xf1, 0xf2, 0xea, 0xed, 0xee, 0xeb, 0xe7

```



## Q8 [1 point]

### [1 point]

Consider the following assembly language program segment. What value will exist in register R0 when execution reaches the BKPT instruction? Express your answer as an 8-digit hexadecimal number.

```

    ldr    r0,=alpha
    adds  r0,#12
    ldr    r0,[r0,#16]
    bkpt
.align 4
alpha:
.word 0x5bc2225d, 0x2e11435c, 0x7de3f7f9, 0xd0c2f4da, 0x8c915360, 0xa35109c9, 0xdb73c99a, 0x726cd203
.word 0x34217b0e, 0xa3bc3446, 0x27086567, 0xcb2ae556, 0xf6897f6a, 0xf3c32a61, 0xe2fa2829, 0x7c8df45b
.word 0x6c53bf33, 0x5157b217, 0xdb4b648a, 0x00f41da9, 0x82b20548, 0xa4969e01, 0x96611536, 0x2ed677e3
.word 0xebcad73b, 0x2a9541d6, 0xb2e36a4c, 0x3f2dfc25, 0xa4ae00d2, 0x8411307b, 0x258a6afa, 0xe5cff6e

```



## Q9 [1 point]

### [1 point]

What ARM Cortex-M0 instruction does the following 16-bit hexadecimal value represent? Be sure to list any immediate operand value as a decimal (base-10) quantity.

**0e5d**



## Q10 [1 point]

### [1 point]

Consider the following assembly language program segment. If the assembler assigns the address for label "abc" to the value shown in the comment, what address will it assign to the label "xyz"? Express your answer as an 8-digit

hexadecimal number.

```
.data
abc: // 0x20000864
.byte 0xfa
.string "abc"
.space 6
.byte 0x60
.hword 0x40cb
.word 0x2a2d5fd7
xyz:
```



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## Q11 [1 point]

[1 point]

Consider the following assembly language program segment. What value will exist in register R0 when execution reaches the BKPT instruction? Express your answer as an 8-digit hexadecimal number.

```
ldr    r0,=0xc47fea64
ldr    r1,=0x62c1d066
orrs   r0,r1
bkpt
```



---

## Q12 [1 point]

[1 point]

How much will the stack pointer change when the following 16-bit instruction is executed? If the stack pointer decreases, you should report a negative number. Express your answer as a positive or negative decimal (base-10) quantity.

**b0c6**



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## Q13 [1 point]

[1 point]

How much will the stack pointer change when the following 16-bit instruction is executed? If the stack pointer decreases, you should report a negative number. Express your answer as a positive or negative decimal (base-10) quantity.

**b586**



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## Q14 [1 point]

### [1 point]

What is the 16-bit hexadecimal encoding of the following instruction? Write exactly four hexadecimal digits with no "0x" prefix.

**subs r6, r5, r2**



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## Q15 [1 point]

### [1 point]

For the following assembly language program segment, what value will exist in register R0 when execution reaches the BKPT instruction? Express your answer as an 8-digit hexadecimal number.

```
ldr    r0,=values
movs   r1,#2
ldrsb  r0,[r0,r1]
bkpt
values:
.byte 0xaf, 0xb2, 0x8c, 0x80, 0x8d, 0x9d, 0xa1, 0xbf
.byte 0xde, 0xd0, 0xda, 0xd3, 0xca, 0xe5, 0xcc, 0xe8
```



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## General Purpose I/O questions

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## Q16 [1 point]

What bit in what register must be to enable the clock to GPIO Port B?

register:

bit position:



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## Q17 [1 point]

Assuming the RCC clock has been enabled for GPIO Port B, and that the current MODER setting is unknown, what values would be needed, below, to configure pins 0, 1, and 7 to be inputs, pins 3, 8, and 15 to be outputs, and leave all other pin configurations unchanged? Keep in mind that the pins you must configure may already be configured for something (their MODER field may not be 00). Specify the values to load into R0 and R1 as 8-digit hexadecimal numbers.

```
ldr r7,=GPIOB
ldr r6,[r7,#MODER]
ldr r0,=
bics r6,r0
ldr r1,=
orrs r6,r1
str r6,[r7,#MODER]
```



R0 =

R1 =

---

## Q18 [1 point]

What RCC register and bit is used to enable the clock to Timer 1?



register:  bit position:

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## Q19 [1 point]

[1 point]

What is the absolute address of the following register? (Not the offset from a base address.) Express your answer as an 8-digit hexadecimal number.

**GPIOB\_BSRR**



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## Q20 [1 point]

[1 point]

Consider the case where all pins of GPIOB are configured for output. When the following code is run, what will the value of the ODR be when execution reaches the BKPT instruction? Express your answer as a 4-digit hexadecimal number.

```
ldr r0,=GPIOB
ldr r1,=0xbfab
```

```
str r1,[r0,#ODR]
ldr r1,=0x78948594
str r1,[r0,#BSRR]
bkpt
```



## Q21 [1 point]

Assuming the RCC clock has been enabled for GPIO Port B, and that the current PUPDR setting is unknown, what values would be needed, below, to configure pins 2, 8, and 12 to be pulled up, pins 4, 10, and 15 to be pulled down, and leave all other pin configurations unchanged? Keep in mind that the pins you must configure may already be configured some other way (their PUPDR field may not be 00). Specify the values to load into R0 and R1 as 8-digit hexadecimal numbers.

```
ldr r7,=GPIOB
ldr r6,[r7,#PUPDR]
ldr r0,=_____
bics r6,r0
ldr r1,=_____
orrs r6,r1
str r6,[r7,#PUPDR]
```



## Q22 [1 point]

### [1 point]

What pin of the microcontroller is used for ADC\_IN0? Express your answer with the three- or four-character abbreviated name for the pin.



## Timer and Interrupt Questions

## Q23 [1 point]

### [1 point]

What is the position number of the TIM2 interrupt in the vector table? (In other words, in which bit position must a '1' be written to the NVIC\_ISER register to enable the interrupt?)



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## Q24 [1 point]

### [1 point]

What is the absolute address of the following register? (Not the offset from a base address.) Express your answer as an 8-digit hexadecimal number.

**TIM6\_EGR**



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## Q25 [1 point]

What values should be loaded into R0 and R1 so that values are written to the NVIC ISER and ICER registers to enable interrupt numbers 0, 19, and 26 and disable interrupt numbers 10, 12, and 13? Specify the values as 8-digit hexadecimal numbers.

```
ldr r7,=NVIC
ldr r6,=ISER
ldr r0,=
str r0,[r7,r6]
ldr r6,=ICER
ldr r1,=
str r1,[r7,r6]
```



R0 =

R1 =

---

## Q26 [1 point]

### [1 point]

Suppose the system clock is 48 MHz, and a timer is initialized so that its RCC clock is enabled, assignments are made to its registers so that PSC = 13859, its ARR = 19742, and the timer's counter is set to run. How many times per second will an update event occur? State your answer with at least 8 significant digits. (Why so many significant digits? We're trying to determine if you know how to add one or subtract one in the right places.)



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## Q27 [1 point]

Write the values needed for the following code to associate pin 0 to GPIO port E for the purpose of enabling an external interrupt on PE0. The values you use must not change the configuration of any other pins. Remember that the four-bit fields in the EXTICR registers might already be set to a non-zero value.

```
ldr r7,=SYSCFG
adds r7,#EXTICR1
movs r0,#_____
adds r7,r0 // remember that each EXTICR register is 4-bytes in size
ldr r6,[r7]
ldr r1,=_____
bics r6,r1
ldr r2,=_____
orrs r6,r2
str r6,[r7]
```

Specify a decimal value for R0 and 4-digit hexadecimal values to load into R1 and R2.

R0 =

R1 =

R2 =



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## Q28 [1 point]

[1 point]

What is the exact name of the interrupt service routine for Timer 7?



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## Q29 [1 point]

[1 point]

Suppose the system clock is 48 MHz, and a timer is initialized so that its RCC clock is enabled, assignments are made to its registers so that PSC = 22703, and the timer's counter is set to run. What should its ARR be set to so that an update event will occur as close as you can get to 0.119748790986269 times per second? State your answer as a positive integer.



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## Q30 [1 point]

Assume that the system clock is 48 MHz. If a program is written that sets the SysTick registers to the following values:

STK\_RVR = 24804,

STK\_CVR = 22626,

STK\_CSR = 3,

(and they are set in that order), how many seconds will elapse between enabling the timer and the first interrupt? How many seconds will elapse between the first interrupt and the second interrupt? Express your answers with at least 8 significant digits. (Why so many digits? We're trying to determine if you understand if you need to add one or subtract one in the right place. Just copy all the digits from your calculator, and it will be enough.)



seconds between enable and 1st interrupt:

seconds between 1st and 2nd interrupts:

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## Part 2: Programming Exercises

This part is graded separately.

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