

Class	CS47, Sec 01
Homework	I
Due Date	Mar 14, 2018 11:59 PM PST
Instructions	<ol style="list-style-type: none"> 1. There are 7 questions with total 10 points. 2. Please create electronic document with your answer. 3. There is no need to include the question itself. However, you MUST include question number and sub-part index if any. Example: 5(b) 4. Please create a PDF document <u>hw1.pdf</u> and <u>upload that in Canvas</u> assignment page by the due date. 5. Please re-check you submission for any logistic errors (empty file, corrupted PDF, and many more) and re-submit if needed. Once grading is started, any file with logistics errors will be given 0 point. 6. NO handwritten (and scanned) document is accepted. You answer must be <u>typed</u> in (and computer drawn if diagram is asked) <u>using word processing software</u>. 7. NO LATE SUBMISSION. 8. Please explain your answer clearly – just writing the final answer in a word or two is not sufficient in most of the cases.

1. A computing system has a processor with 128 64-bit registers and runs on 1.2 GHz clock. This processor has 40-bit address bus connected to memory and data bus connected to memory is 64-bit wide. The memory runs on 600 MHz clock and word addressable (i.e. each address stores a complete word). The memory takes one memory clock cycle for read and write operation. Upon completion of read operation, processor needs to wait for one processor clock cycle before another memory read or write operation.
 - a. What is the size of register file in KB unit? [0.25pts]
 - b. What is the clock period of processor clock in 'ns' unit (up to 3 decimal place)? [0.25pts]
 - c. What is the size of memory in TB unit? [0.25pts]
 - d. If this computing system is doing 2 million data transaction with 40% write operations, how much time is spent in milli-second (ms) unit to complete this data transaction? [1.25pts]
2. A number system 'rainbow' uses 7 symbols to express any positive integer values. These symbols and their corresponding decimal values are as following: V:= 6, I:= 5, B:= 4, G:= 3, Y:= 2, O:= 1, R:= 0. Given this answer the following.
 - a. What is decimal representation for a value represented in 'rainbow' number system as VIBGYOR? [0.5pts]
 - b. A value represented in decimal number system as 43256. What is it's 'rainbow' representation? [0.5pts]

3. A 64-bit MIPS system has 256 registers. It has three types of instruction R, I, and J similar to 32-bit MIPS. The I type instruction supports 32-bit immediate field value.
 - a. How many total instructions can be supported in this machine? **[0.5pts]**
 - b. What is jump address range in J-type instruction assuming no address translation is happening? **[0.5pts]**
4. Review the following MIPS assembly code.
 - a. Write code that the assembler will assemble after macro expansion of the code. **[0.5pts]**
 - b. Show the symbol table for this code using relative index of instruction starting at 1. **[0.5pts]**

```
.macro mac1 ($arg1)
add $arg1, $arg1, $arg1
addi $arg1, $arg1, -1
.end_macro

.macro mac2 ($arg1, $arg2)
mac1($arg2)
sub $arg1, $arg1, $arg2
.end_macro

.text
L1:  addi $t1, $zero, 10
      addi $t2, $zero, 5

L2:  mac1($t1)
      beq $t1, $t2, L4

L3:  mac1($t2)
L4:  mac2($t2, $t1)

L5:  bne $t2, $t1, L2
```

5. If code in Q4 is loaded into a 32-bit MIPS based computing system, determine symbol table corresponding to the code with actual address values. **[1.0pts]**
6. Review the following data declaration code and show corresponding memory layout in a byte addressable memory attached to a 32-bit MIPS processor following little-endian data arrangement for multi-byte data (In a table show higher address at top row and lower address at bottom row). Explain this memory layout of data. Also assume that the memory has been reset to all 0 content at beginning. **[2.0pts]**

```
.data
va: .byte 0x2A
vb: .word 0x12EF2C
vc: .asciiz "abcd"
vd: .half 0x1234 0xEFB2
ve: .word 0x75AB45C1
```

7. Review the following sub routine implementation and answer the following question.
- List all the registers that should be stored in frame of this sub-routine. **[0.5pts]**
 - What is the frame size in byte unit for this sub-routine? **[0.5pts]**
 - If this sub-routine is called from a program with \$a0=10, \$a1=0x10010000, \$a2=0x10010040, \$a3=0x10010044, then what is the maximum amount of stack memory consumption before control is back to main routine? **[1.0pts]**

<pre> sum_n_max: #TBD: Frame Creation # Body beq \$a0, \$zero, sns_end addi \$t0, \$a0, -1 addi \$t1, \$zero, 4 mult \$t0, \$t1 mflo \$t0 add \$t1, \$a1, \$t0 lw \$s0, 0(\$a1) lw \$s1, 0(\$t1) add \$s2, \$s1, \$s0 sw \$s2, 0(\$a3) </pre>	<pre> lw \$t0, 0(\$a2) slt \$t1, \$t0, \$s2 beq \$t1, \$zero, sns_cont sw \$s2, 0(\$a2) sns_cont: addi \$a0, \$a0, -2 addi \$a1, \$a1, 4 addi \$a3, \$a3, 4 jal sum_n_max sns_end: #TBD: Frame restoration jr \$ra </pre>
--	---