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| **Project:** | Alter the MARIE Instruction Set Architecture to include two new instructions designed to improve the performance of your binary search and exponentiation programs.  Add a divide-instruction for the binary search program and a multiply-instruction for the exponentiation program.<br><br>Design, implement, and test an assembler for the new Instruction Set Architecture that was discussed above. Your assembler accepts a text file and produces a binary file suitable for execution by the ISA interpreter that you will design and build in project p03.<br><br>Test your assembler by modifying the binary search and exponentiation programs you created in project p01 to include the new instructions defined in the new ISA.<br><br>Test your assembler by assembling the two New Architecture programs. |
| **Deliverables:** | Copies of the source for the following five deliverables are included in the document that you submit to your instructor.<br>**Name**: The document is named CRN-*author1*-*author2*-**p02.docx**.   For example, if the team consisting of Ms. Fiona **Faultless** and Ms. Petunia **Perfect,** enrolled in section CRN **11068**, submits project p02, the file name of their document would be **11068-Faultless-Perfect-p02.docx**.  The team must attach their document to the note sent to your instructor. Please employ the template, http://cs2.uco.edu/~trt/cs3833/p02Template.docx to document your interpreter. |
| **1.** | A complete description of the new Instruction Set Architecture presented in tabular form using **Table 4.2** on page 238 as a guide and including all of the instructions in the new architecture.  Please include a figure similar to **FIGURE 4.10** also that specifies the instruction format. |
| **2.** | An assembler that reads a program that conforms to the ISA defined in project p01 and produces a binary executable file that can be executed by the interpreter that you will design in project p03<br><br>**File Names**: Store all the source files that are required to create the executable in a folder named **p02**.  Name the executable **mas**.  Name the makefile used to create the executable **makemasm**.<br><br>**Compilation Error Penalty**:  **No credit** is assigned to any submission that fails to produce an executable file.  Compilation warnings will be severely penalized. |

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| **2. Continued** | All source files must contain an author identification comment similar to:<br>//---------------------------------------------------------------------------------------<br>//Author1:     Mr. Charles Babbage<br>//Student ID:   *00000000<br>//E-Mail:     cbabbage@uco.edu<br>//Author2:     Ms. Ada Lovelace<br>//Student ID:   *00000001<br>//E-Mail:     alovelace@uco.edu<br>//Course:      CMSC 3833 – Computer Organization II<br>//CRN:        10931, Autumn, 2019<br>//Project:      p02<br>//Due:         September 16, 2019<br>//Account:    tt001<br>//---------------------------------------------------------------------------------------<br>Submit *only* the source files that you have changed. It is likely, though not assured, that the files you will have altered are:<ul><li>masopcodes.h</li><li>maspar.y</li><li>maslex.l</li></ul> |
| **3.** | File **NA-BS.mas**. This file exploits the new ISA to implement a binary search. When this file is assembled the executable performs a binary search on the new ISA MARIE simulator that you will create in project p03. Store this file in folder **p02**.<br>Your file NA-BS.mas must have an author identification comment that is similar to:<br>/Author1:     Mr. Charles Babbage<br>/Student ID:   *00000000<br>/E-Mail:     cbabbage@uco.edu<br>/Author2:     Ms. Ada Lovelace<br>/Student ID:   *00000001<br>/E-Mail:     elovelace@uco.edu<br>/Course:      CMSC 3833 – Computer Organization II<br>/CRN:        10931, Autumn, 2019<br>/Project:      p01<br>/Due:         September 16, 2019<br>/File:          M-BS.mas |
| **4.** | Time Complexity Analysis for the new architecture MARIE binary search program. Find $T(n)$ where $n$ is the number of values to search and $T(n)$ is the number of instructions executed to find the key value. |
| **5.** | File **NA-EX.mas**. This file exploits the new ISA to implement an exponentiation program that finds $a^b$ where $a$ and $b$ are both positive integers and $a^b < 2^{15}$. When this file is assembled the executable exponentiates $a^b$ on the new ISA MARIE simulator that you will create in project p03. Store this file in folder **p02**. Your file **NA-EX.mas** must have an author identification comment that is similar to that described above. |

| 6. | Time Complexity Analysis for the MARIE exponentiation program implemented by exploiting the new ISA. Find $T(n)$ where $n$ is a function of $a$ and $b$, and $T(n)$ is the number of instructions executed to find $a^b$. |
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| **Electronic Submission:** | You and your partner make a single submission. Attach your document containing the description and sources for your assembler to a note to me trturner@uco.edu. |

**Scoring Block**

| Section | Available | Earned | Explanation |
|---|---|---|---|
| New Instruction Set Architecture including a table similar to **Table 4.2** and a figure similar to **FIGURE 4.10** | 5 | 5 | |
| Marie Assembler (**mas**) | 25 | 25 | |
| New Architecture Binary Search | 5 | 5 | |
| New Architecture Binary Search Time Complexity | 5 | 5 | |
| New Architecture Exponentiation | 5 | 5 | |
| New Architecture Exponentiation Time Complexity | 5 | 5 | |
| **Total** | **50** | **50** | |