**Assignment Instructions**

*Answer the following questions. TYPE your answers below each question and submit this as instructed on the class web site.*

***Q1:*** For each of the following programs, translate each line of machine code to an English description. Then describe in a sentence or two what the program does.

A)

|  |  |  |
| --- | --- | --- |
| 0 | 901 |  |
| 1 | 310 |  |
| 2 | 901 |  |
| 3 | 110 |  |
| 4 | 310 |  |
| 5 | 901 |  |
| 6 | 110 |  |
| 7 | 902 |  |
| 8 | 000 |  |

Description:

B)

|  |  |  |
| --- | --- | --- |
| 0 | 901 |  |
| 1 | 315 |  |
| 2 | 805 |  |
| 3 | 513 |  |
| 4 | 315 |  |
| 5 | 214 |  |
| 6 | 808 |  |
| 7 | 610 |  |
| 8 | 514 |  |
| 9 | 315 |  |
| 10 | 515 |  |
| 11 | 902 |  |
| 12 | 000 |  |
| 13 | 000 | DATA |
| 14 | 100 | DATA |
| 15 | 000 | DATA |

(Hint - try this one with a variety of inputs… negative, positive, large positive…)

Description:

C)

|  |  |  |
| --- | --- | --- |
| 0 | 511 |  |
| 1 | 110 |  |
| 2 | 311 |  |
| 3 | 902 |  |
| 4 | 512 |  |
| 5 | 210 |  |
| 6 | 312 |  |
| 7 | 709 |  |
| 8 | 600 |  |
| 9 | 0 |  |
| 10 | 1 | DATA |
| 11 | 0 | DATA |
| 12 | 5 | DATA |

(Hint - watch the output as it runs - it outputs more than one time)

Description:

***Q2:*** Below you will find a list of instructions. Convert the given English instructions to machine codes. Then run the program and describe what it does with the inputs (hint: don't use numbers that are too big!)

|  |  |  |
| --- | --- | --- |
| 0 |  | Get input |
| 1 |  | Store in location 15 |
| 2 |  | Get input |
| 3 |  | Store in location 16 |
| 4 |  | Load location 18 |
| 5 |  | Add location 15 |
| 6 |  | Store in location 18 |
| 7 |  | Load location 16 |
| 8 |  | Subtract location 17 |
| 9 |  | Store location 16 |
| 10 |  | Branch if = 0 to location 12 |
| 11 |  | Branch always to location 4 |
| 12 |  | Load 18 |
| 13 |  | Output |
| 14 |  | Halt |
| 15 | 0 | DATA |
| 16 | 0 | DATA |
| 17 | 1 | DATA |
| 18 | 0 | DATA |

Description:

***Q3:*** Below the LMC Assembly is given for a program. Convert it to machine code, write the instructions below. Then run it, and say what it does:

|  |  |  |
| --- | --- | --- |
|  | Machine | Assembly |
| 0 |  | INP |
| 1 |  | STA FIRST |
| 2 |  | INP |
| 3 |  | STA SECOND |
| 4 |  | SUB FIRST |
| 5 |  | BRP OPTIONA |
| 6 |  | LDA SECOND |
| 7 |  | BRA OPTIONB |
| 8 |  | OPTIONA LDA FIRST |
| 9 |  | OPTIONB OUT |
| 10 |  | HLT |
| 11 |  | FIRST DAT 0 |
| 12 |  | SECOND DAT 0 |

(Hint - try switching the order you give two values.)

Description:

***Q4:*** Write LMC Assembly AND machine code for a program that gets two numbers from input and subtracts the second from the first then outputs the result. (Inputs of 10 and 4 should result in 6). You do not have to use all the lines provided and may add more if needed:

|  |  |  |
| --- | --- | --- |
|  | Machine | Assembly |
| 0 |  |  |
| 1 |  |  |
| 2 |  |  |
| 3 |  |  |
| 4 |  |  |
| 5 |  |  |
| 6 |  |  |
| 7 |  |  |
| 8 |  |  |
| 9 |  |  |
| 10 |  |  |

***Q5:*** Write LMC Machine code (assembly is optional) for a program that takes in a number as input. If the input is >= 50, your program should output 1. If the input number is less than 50, output 0. You do not have to use all the lines provided and may add more if needed:

|  |  |  |
| --- | --- | --- |
|  | Machine | Assembly (Optional) |
| 0 |  |  |
| 1 |  |  |
| 2 |  |  |
| 3 |  |  |
| 4 |  |  |
| 5 |  |  |
| 6 |  |  |
| 7 |  |  |
| 8 |  |  |
| 9 |  |  |
| 10 |  |  |
| 11 |  |  |
| 12 |  |  |
| 13 |  |  |
| 14 |  |  |
| 15 |  |  |
| 16 |  |  |
| 17 |  |  |
| 18 |  |  |

***Optional Challenge Problem:***

*Write LMC code that will divide a number by 2 and output the answer (ignore any remainder). Input of either 8 or 9 should print 4.*

*Think of division as repeated subtraction…*