# Workshop 04 - Instructions

**Core Body of Knowledge (CBOK)  Areas:** abstraction, design, hardware and software, data and information, and programming.

Read the Questions below and prepare your answers for your session. Show your development of your answers in the logbook for this assignment in the web-submission system

[**https://cs.adelaide.edu.au/services/pracmarker/**](https://cs.adelaide.edu.au/services/pracmarker/)

#### Question 1

Look at the diagram of the machine on slide 8 of lecture 7 of this course. Consider the A-instruction format:

0vvv vvvv vvvv vvvv

Answer the following:

a) What does an A-instruction do?

b) Draw a diagram of a circuit which will

1) detect that instruction currently emitted from the ROM is an A-instruction and

2) perform the appropriate updates (hint, the diagram on slide 8 of lecture 7 does not contain all the wires for the registers. Look at the register chip diagram on page 49, chapter 3, of the text book.

#### Question 2

Consider the C instruction format:

111a c1c2c3c4c5c6 d1d2d3 j1j2j3

Now look at figures 4.3, 4.4 and 4.5 in chapter 4 of the textbook. Now what is the binary encoding of:

a)  D=M

b)  D;JEQ

c)  D=D+1;JGT

Briefly explain what each of the above commands mean.

#### Question 3

Write Hack machine code that sums 10 consecutive values starting at location:

**array** and stores the sum of these numbers in location: **sum**. Run your program in the CPU emulator.

#### Additional Questions

#### Question 4

The destination of the C-instruction can be A, M, D, AD, AM, DM, and DMA. Draw an implementation of the logic for the output wire of the ALU that writes output to the correct target registers. Hint: think about which bits of the C instruction are directed to which chips.

#### Question 5

Why is it that the instruction:

M=A

unlikely to make sense in most circumstances? The instruction:

D=M;JMP

also rarely makes sense – why?

#### Question 6

Draw the wiring that implements the logic for JMP. Note that this wiring will affect the PC.

#### Question 7

Draw the wiring that implements the logic for JEQ. Note that this wiring is affected by the output of the ALU.