4.

(a) Explain in detail how procedures (including parameters) are defined and processed in MIPS.

[12 Marks]

(b) Suppose that there is a procedure swap(int &a, int &b) which swaps the values assigned to a and b. Write this procedure in MIPS, being sure to include comment lines in your code.

[10 Marks]

(c) The following is pseudo MIPS code that implements a function with one argument n.

Assumptions:-

The argument (n) is in $4

$11 and also $8 are initialised to 1

```
MAIN :      addi $4,$0,4            #the argument n = 4
            jal fact                #
                                    #would eg print result here

fact:       beq $4,$11,RETURN       #
            push($31)               # no such instruction
            push($4)                # no such instruction
            addi $4,$4,-1           #
            jal fact                #
RETURN:     $4 = pop()              #!
            $31 = pop()             #!
            mult $8,$8,$4           #
            jr $31                  #
```

Fill in the comment lines, to explain each instruction. Those instructions where there is the comment 'no such instruction' should be rewritten as correct MIPS instructions. Explain what the function does, for example, when n is initialised to the value 3.

[11 Marks]

TURN OVER

5.

(a) Explain what is meant by the ‘principle of locality’ in memory hierarchy systems, and why it is important? What is meant by the terms ‘cache hit’ and ‘cache miss’ in the context of memory hierarchy?

[10 Marks]

(b) There is an 8 word direct mapped cache, with a word length of 8 bits. Initially the cache is empty, and the following sequence of memory addresses are referenced for reading: 17, 6, 22, 8, 17, 24. Show the state of the cache after each read, using this to explain how such a system works. How would such a system need to be amended to fully take account of the principle of locality?

[15 Marks]

(c) Explain what is meant by ‘virtual memory’ and in particular how a virtual address is mapped to a physical address.

[8 Marks]

END OF PAPER