UNIVERSITY OF ABERDEEN SESSION 1999-00

Degree Examination in
EG2068 ELECTRONICS AND MICROPROCESSORS

24th January 2000 9 am - 11 am

NOTES: (i) Candidates are permitted to use approved calculators.
(ii) Candidates are not permitted to use the Engineering Mathematics handbook.
(iii) An ASCII table is provided.

Candidates should attempt ALL questions in Section A and TWO questions from Section B.

SECTION A

1. (a) Convert the following decimal number to **binary**; (you must indicate your method of working; simply using a calculator will not be acceptable): +30 [2 marks]

(b) Describe the operation of taking the one's complement of a 32 bit number, illustrating your answer by giving the **hexadecimal** value of the decimal number -3 [2 marks]

(c) Describe the process of converting a binary number to a decimal value. Illustrate this by converting the following **binary** number: 1000000000000001 [2 marks]

(d) What is the result in r0 (expressed in **hexadecimal)** after executing the following series of three instructions?

```
MOV r0, #0x55
AND r0, #0x17
OR r0, #0x11
```
[2 marks]

(e) What is the hexadecimal value of -2 when stored as a 2's complement **integer**?
[2 marks]

2. (a) Give one example of a high level programming language. [1 mark]

(b) What is the name of the register in the Dispatch Unit which stores the operand and opcode of the currently executing instruction? [2 marks]

(c) Describe the execution of an "ADD with Carry" (ADDC) instruction within the Integer Unit. When may a programmer need to use this instruction? [2 marks]

(d) Explain in detail the execution of the instruction "MOV r1, 2(r0)" [2 marks]

(e) Explain the operation of the instruction **"**`PUSH.W r0`**"** [3 marks]

3. The following truth table contains the specification of a combinational logic circuit that you have been asked to implement. Compare and contrast the complexity of the direct implementation to that resulting from the minimisation of the logic required by means of *either* **Boolean algebraic** or **graphical techniques**. [10 marks]

A	B	C	D	F
0	0	0	0	0
0	0	0	1	0
0	0	1	0	1
0	0	1	1	1
0	1	0	0	1
0	1	0	1	1
0	1	1	0	1
0	1	1	1	1
1	0	0	0	0
1	0	0	1	0
1	0	1	0	1
1	0	1	1	1
1	1	0	0	1
1	1	0	1	1
1	1	1	0	1
1	1	1	1	1

4. (a) Minimise the following truth table, using **graphical mapping techniques** to produce a result which may be subsequently factorised. [8 marks]

A	B	C	D	F
0	0	0	0	0
0	0	0	1	0
0	0	1	0	1
0	0	1	1	1
0	1	0	0	1
0	1	0	1	1
0	1	1	0	1
0	1	1	1	1
1	0	0	0	0
1	0	0	1	0
1	0	1	0	1
1	0	1	1	1
1	1	0	0	1
1	1	0	1	1
1	1	1	0	1
1	1	1	1	1

(b) Why is it not normal practice to use such factorisation when implementing actual logic circuits? [2 marks]

SECTION B

5. (a) The following C procedure evaluates the factorial of a number:

```
int factorial(number);
    int number;
{
    integer product, count, counter;
    count = number;
    product= 1;
loop:
    product=count*product;
    count--;
    if (count > 1) {goto loop;}
    return (product);
}
```

Trace the execution of the program when called with a value of 3 by showing a snapshot of the value of each variable after executing each line of the program. [6 marks]

(b) If the stack pointer and program counter are 4 bytes long, sketch the stack frame set up by calling the procedure "`factorial`". [6 marks]

(c) What are the advantages in using procedures to write programs? [4 marks]

(d) The statement "if (count > 1) `{...}`" compiles to a machine code branch instruction. Explain how a branch instruction allows a conditional jump to a particular address.[4 marks]

6. (a) The following table shows the function of a voting system that you have been asked to design. *A*, *B* and *C* are switches that are to be given to the panel in a television programme. The panel is going to be asked to vote on a series of topical issues and your design should indicate the outcome of the vote with two lights named *Loose* and *Win.* The switches have been arranged to give a logic '1' output when they are depressed and a logic '0' when they are released.

A	**B**	**C**	**Loose**	**Win**
0	0	0	1	0
0	0	1	1	0
0	1	0	1	0
0	1	1	0	1
1	0	0	1	0
1	0	1	0	1
1	1	0	0	1
1	1	1	0	1

Design the digital electronics necessary to implement the above system, carefully showing each stage in the process. (10 marks) In particular, ensure that you consider carefully the complexity of the resulting implementation and that you have taken the necessary steps to minimise this. [5 marks]

The design implied above has a number of shortcomings. One of these is that, once the panel has released their buttons, the result of the vote is lost. How might you add some additional logic to the design to overcome this problem? [5 marks]

(b) Consider the following C code fragment:

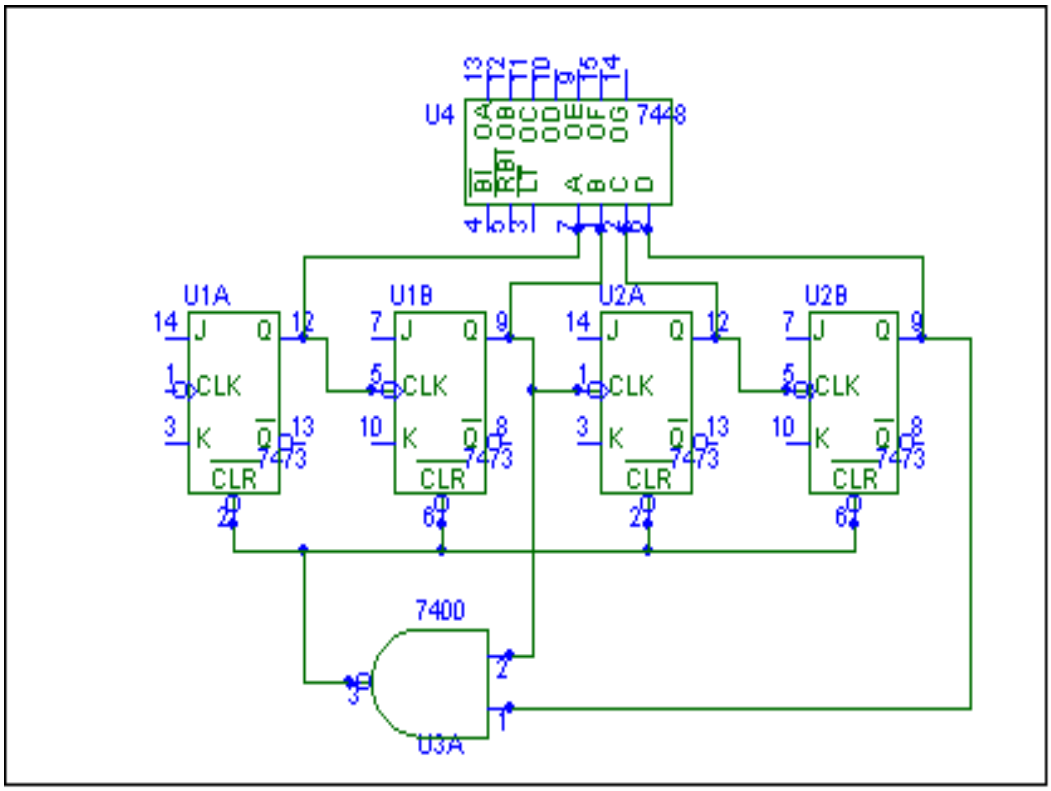
```
main()
{
        int list[4];
        int count;
        count = 0;
loop:
        list[count]=count*count;
        count++;
        if (count <= 4) {goto loop;}
        printf("Done.\n");
}
```

What values are stored in the array "list"? [4 marks]

(c) The above program contains an error which could corrupt other data in the computer; What is the error? [2 marks]

(d) The program uses the "printf" library function to print a string. How is a string stored in the computer memory? [4 marks]

7. The schematic diagram below shows part of a digital electronic circuit.



(a) Describe, in detail, the function of this circuit. [2 marks]

(b) Discuss the purpose of the gates *U1* (a & b) and *U2* (a & b). [2 marks]

(c) The inputs J & K of gates *U1* & *U2* have not been connected in this diagram. Is this necessary? Give your reasons. [2 marks]

(d) What is the function of the gate marked *U3A*? Discuss in detail how this gate operates in the above circuit. [5 marks]

(e) What is the function of the gate marked *U4*? In particular suggest where the pins marked *OA* to *OG* should be connected. [5 marks]

(f) Where should pin 1 of *U1a* be connected? [2 marks]

(g) What functions do the pins RBI and LT on the gate U4 perform? [2 marks]