Family Name: . . . . . .
Other Names: . . . . . .
ID Number: . . . . . .

ENGR101: Test

4 May 2009

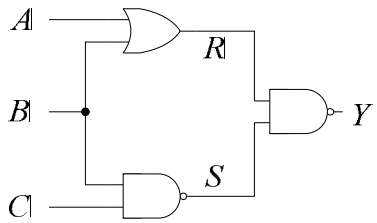
Instructions

- Time allowed: 45 minutes.
- There are 45 marks in total.
- Answer all the questions.
- Write your answers in the boxes in this test paper and hand in all sheets. You may ask for additional paper if you need it.
- If you think some question is unclear, ask for clarification.
- Knob and Switch Assembly language documentation is provided on a separate sheet.
- This test will contribute 15% of your final grade, if it helps your grade.
- Non-electronic translation dictionaries are permitted.
- Calculators are not permitted.

Question	**Marks**	
1. Boolean algebra.	[6]	
2. Constructing a circuit.	[4]	
3. Number representation	[4]	
4. Adders	[4]	
5. ALU	[2]	
6. Software	[4]	
7. Understanding assembly language	[4]	
8. Writing assembly language	[7]	
9. IO Management	[5]	
10. Memory Management	[5]	
Total	[45]	

SPARE PAGE FOR EXTRA ANSWERS
Cross out rough working that you do not want marked.
Specify the question number for work that you do want marked.

Question 1. Boolean algebra. **[6 marks]**



(a) [2 marks] Consider the circuit above, write expressions for *R* and for *S*.

(b) [1 mark] What is *Y* as a function of *R* and *S*?

(c) [1 mark] Substitute your results from part (a) into that from part (b) to obtain an expression for *Y* as a function of *A*,*B* and *C*.

(d) [2 marks] Use DeMorgan's rule to show that $Y = \overline{A}\overline{B} + BC$.

SPARE PAGE FOR EXTRA ANSWERS
Cross out rough working that you do not want marked.
Specify the question number for work that you do want marked.

Question 2. Constructing a circuit. **[4 marks]**

Draw a circuit that produces a single output $Y = A + X + \overline{C}.\overline{D}$, where $X = \overline{A} \oplus B$.

SPARE PAGE FOR EXTRA ANSWERS
Cross out rough working that you do not want marked.
Specify the question number for work that you do want marked.

Question 3. Number representation. **[4 marks]**

(a) [1 mark] Express 23_{10} as the sum of powers of two.

(b) [1 mark] What is the binary representation of 23_{10}?

(c) [2 marks] Write the eight-bit 2's complement representation of -23_{10}. Ensure that you show your working and/or explain your conversion technique.

SPARE PAGE FOR EXTRA ANSWERS
Cross out rough working that you do not want marked.
Specify the question number for work that you do want marked.

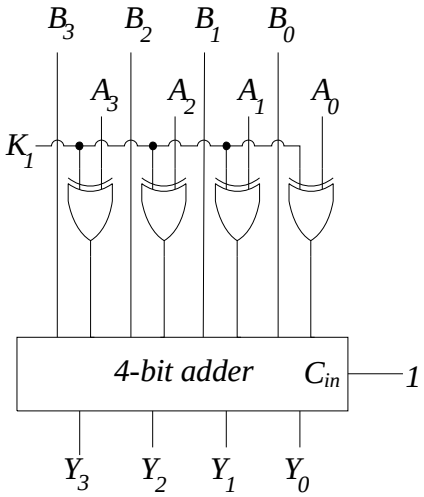
Question 4. Adders **[4 marks]**

(a) [2 marks] Draw truth tables for the carry-out and sum outputs of a half-adder having inputs *A* and *B*. Remember that there is no carry-in to a half-adder.

(b) [2 marks] Use your truth tables to write Boolean expressions for the carry-out and sum outputs.

SPARE PAGE FOR EXTRA ANSWERS
Cross out rough working that you do not want marked.
Specify the question number for work that you do want marked.

Question 5. ALU. **[2 marks]**



(a) [1 mark] What is the function of the XOR gates in the partial ALU circuit shown above?

(b) [1 mark] What operation does the entire circuit perform when $K_1 = 1$.

SPARE PAGE FOR EXTRA ANSWERS
Cross out rough working that you do not want marked.
Specify the question number for work that you do want marked.

Question 6. Software. **[4 marks]**

(a) [2 marks] Briefly explain the main reason why not all microcode has machine language equivalents and give an example.

(b) [2 marks] Briefly explain the main differences between a compiler and an interpreter.

SPARE PAGE FOR EXTRA ANSWERS
Cross out rough working that you do not want marked.
Specify the question number for work that you do want marked.

Question 7. Understanding assembly language. **[4 marks]**

Consider the assembly language program below. Compute the final value of R0. What is the final value as a function of the initial values of R0 and R2.

Assume that R0 initially contains the value 5, R1 initially contains the value 1 and that R2 contains the value 4.

```
0: ADD R0 R0 R0
1: SUB R2 R2 R1
2: BZERO 4
3: BRANCH 0
4: HALT
```

SPARE PAGE FOR EXTRA ANSWERS
Cross out rough working that you do not want marked.
Specify the question number for work that you do want marked.

Question 8. Writing assembly language. **[7 marks]**

(a) [5 marks] Write an assembly language program that computes the smaller of two values. The first value is stored in memory location 20, the second value is stored in memory location 21 and the result of the comparison should be stored in memory location 22.

(b) [2 marks] Construct the symbol table for the following assembly language program. Assume that code starts at memory location **10** and data at memory location **100**.

```
0: LOAD R0 a
loop:
1: ADD R0 R0 R0
2: STORE a R0
3: BRANCH loop
```

SPARE PAGE FOR EXTRA ANSWERS
Cross out rough working that you do not want marked.
Specify the question number for work that you do want marked.

Question 9. IO Management. **[5 marks]**

Consider the HACK computer architecture. Remember that this is a simple computer that uses memory mapped IO to communicate with the keyboard and the screen. Briefly describe the steps involved in implementing the following operation in a high-level language such as Java:

System.out.println("All mimsy were the borogoves,");

SPARE PAGE FOR EXTRA ANSWERS
Cross out rough working that you do not want marked.
Specify the question number for work that you do want marked.

Question 10. Memory management. **[5 marks]**

A friend has just bought a HACK computer system that support virtual memory management. It has two pages of 32Kb making a total of 64Kb of RAM free for application programs and a hard drive with a swap file that can hold up to six pages of data.

What is the maximum size of an application program that can be run on the computer in pages (explain the reasons behind your calculation)? Can you explain the effect that running many small application programs at once might have on the overall speed of his computer?