Family Name: . . . . . **Other Names:** . . . . . .

ID Number: . . . . . **Signature** . . . . . .

ENGR 101: Test 2

30 May, 2016

Instructions

- Time allowed: **50 minutes** .
- Answer **all** the questions. There are 50 marks in total.
- Write your answers in the boxes in this test paper and hand in all sheets.
- If you think some question is unclear, ask for clarification.
- This test contributes 20% of your final grade
- You may use paper translation dictionaries, and calculators without a full set of alphabet keys.
- You may write notes and working on this paper, but make sure your answers are clear.

Questions	**Marks**	
1. Boolean Algebra, Adders and Logic Gates	[9]	
2. CPU Architecture	[8]	
3. Software Quality and Testing	[8]	
4. Professional Engineering	[6]	
5. User Testing and the Scientific Method	[6]	
6. Error signals, Control systems and PID	[5]	
7. Engineering Research Topic	[8]	
	TOTAL:	

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.

1. Boolean Algebra, Adders and Logic Gates **(9 marks)**

(a) **(3 marks)** For the boolean expression $Y = ABC + \bar{A}BC + A\bar{B}\bar{C} + \bar{A}\bar{B}\bar{C}$, draw a Karnaugh map and use it to simplify the expression for Y.

Y =

(b) **(3 marks)** Draw a logic circuit diagram for $Y = C.(\bar{A} + B)$

(c) **(3 marks)** If you are adding two 2-bit unsigned binary numbers together, state how many half and full adders you would need to perform the calculation and draw a labelled diagram showing how they should be laid out (including bit inputs, and both sum and carry outputs where appropriate).

Number of half-adders required:
Number of full-adders required:
Diagram:

2. CPU Architecture **(8 marks)**

(a) **(2 marks)** Explain the function of a multiplexer (MUX) in a logic circuit.

(b) **(4 marks)** The ALU has 5 control lines that between them instruct the ALU what to do. These are summarised in the table below:

K_4	K_3	K_2	K_1	K_0	**Function**
0	0	0	0	0	A OR B
1	0	1	0	0	NOT A
1	1	1	0	0	-A
0	1	1	0	0	B-A
X	X	X	0	1	A XOR B
X	X	X	1	0	A OR B
X	X	X	1	1	A AND B

What would the output be for the following machine code? Make sure you show how the machine code is interpreted, and the end result of the computation.
Note: The inputs A and B are in 4-bit binary and 2's complement notation.

11101 0111 0101

ALU Process:

Binary Output:

(c) **(2 marks)** What is a 1-bit register and how does it relate to RAM?

3. Software Quality and Testing **(8 marks)**

You have been provided with a C method that takes two integers as inputs and attempts to the divide the second (b) by the first (a) and return the output (c). Unfortunately the method does not work as expected. For example:

```
int dividing(int a, int b){
        //the actual code that declares c and does the dividing would be here
        return c;
}
```

(a) **(4 marks)** For the method above, list 2 test cases that could be test the functionality of the method. Explain what each test case tests, and the expected output should the method work correctly.

Test Case #1
Test Case #1 given input:

Test Case #1 expected output:

Test Case #1 explanation:

Test Case #2
Test Case #2 given input:

Test Case #2 expected output:

Test Case #2 explanation:

(b) **(2 marks)** Give two reasons why debugging tools, such as those in BlueJ, can be more helpful than print statements alone when debugging.

Reason #1:

Reason #2:

(c) **(2 marks)** The *dividing* method is part of a larger code base of interconnected classes and methods. Once you have debugged the *dividing* code, the rest of the code base no-longer functions. State how a version control system can help avoid or resolve this issue and give an example of one that is commonly used.

Explanation:

Example of a common version control system:

4. Professional Engineering **(6 marks)**

You have been employed to construct and maintain a database of medical images (and meta-data) for doctors to use when diagnosing patients and monitoring their health outcomes. The database is accessible via a website portal.

The database and website breaks and causes downtime according to the following table.

Down time (hours per year)	0.5	1	5	12	24
Probability of occurence	20%	15%	0.5%	0.25%	0.1%

(a) **(2 marks)** Calculate the down time expected for a year. Make sure to show your working.

Yearly downtime:

(b) **(4 marks)** Identify and rank (from most important to least) the most relevant 3 aspects of software quality (from the total 6) in terms of importance for this project. Justify your choices.

Software Quality measures
#1 (Most important):

#2:

#3 (Least important):

5. User testing and the scientific method **(6 marks)**

In early 2016 the Oculus Rift, a virtual reality headset, was made available for pre-order to the general public for US$599. Currently, three controller systems can also be used with the Rift: a keyboard and mouse, an X-box controller or a custom built 'Touch' controller produced by Oculus themselves. A large online electronics retailer has asked you to perform an experiment to assess which controller is 'best' so that they can recommend it to their customers who have already purchased the Rift.

You have been asked to construct a **scientific** experiment to assess which controller is 'best'.

(a) **(2 marks)** The scientific method can be summarised as **empirical falsifiability**. What does this mean?

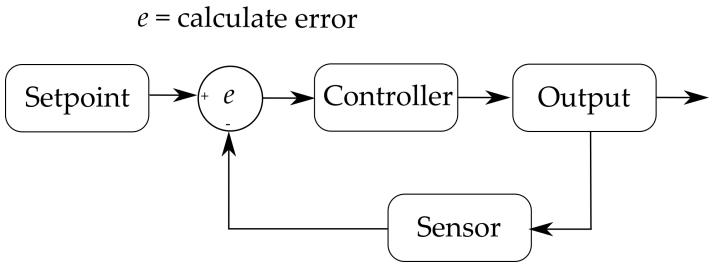
You decide that your experiment will consist of 6 case studies on male users aged between 18 and 25. Two case studies for each control method (keyboard and mouse, x-box controller and the 'Touch' controller).

(b) **(4 marks)** State and explain two potential sources of bias in the experiment described in (c).

First Bias:

Second Bias:

6. Error signals, Control Systems and PID **(5 marks)**



The diagram above is an example of a closed loop control system.

(a) **(3 marks)** Explain what an error signal is and give an example of how one may be calculated.

(b) **(2 marks)** State two benefits of PID control compared to simply using `conditional statements` to respond to an error signal.

Benefit #1:

Benefit #2

7.
Engineering Research Topic **(8 marks)**

During the ENGR101 lectures you were provided with a series of readings and talks about research topics at the School of Engineering and Computer Science at Victoria University. Pick **ONE** of the following topics and give a concise introduction to it based on the content from one of these talks and readings. You must include at least some technical detail about the field and name a company that utilizes that form of Engineering or Computer Science as part of its business. You may include diagrams if they assist in your explanation.

- Machine Learning
- Self-driving vehicles
- Computer Graphics
- Fourier Transform in Sound
- Information Security
- Distributed Computing
- Mars Curiosity Rover

SPARE PAGE FOR EXTRA ANSWERS

Cross out rough working that you do not want marked.
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