Surname:

Other Names:

Student ID number:

ENGR101 Engineering Technology

Test Two – 15th May 2014

Instructions:

Total time allowed 45 minutes

There are 40 marks in total

Answer all questions

Write your answers on this sheet and take care to hand in all sheets. Additional paper is available should you need it.

Show your working.

This test contributes 8% of your final grade

Non-electronic translation dictionaries are permitted

Calculators are **not** permitted

Marking

Part 1: Logic and Boolean Algebra	/20
Part 2: Systems and Signals	/20
TOTAL:	

Part 1: Logic and Boolean Algebra

<u>Core Section (for 65% of marks)</u>

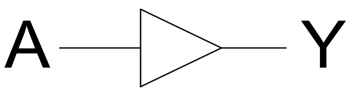
Q1. State one reason why it is important to learn about logic and logic gates.
[1 marks]

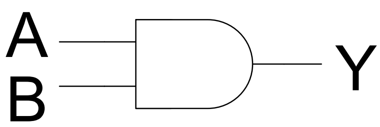
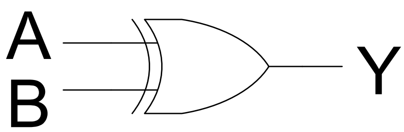
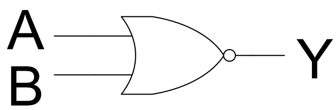
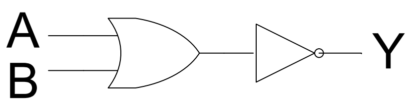
Anything along the following lines would have received full marks

- To enable a better understanding of how to evaluate logic statements in code and how the hardware might be constructed to do this
- To better understand the behaviour/design of electronic circuits

Q2. For each of the following statements, draw out the corresponding logic gate schematic. [6 marks]

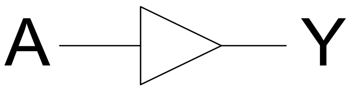
For example, the buffer gate, whose behaviour can be described by the statement, Y = A, would be drawn as follows:



Logic statement	**Depiction**
Y = A AND B	
Y = A XOR B	
Y = $\overline{(A + B)}$	 OR 

Q3. Write down the logic statement corresponding to the following logic gates, and draw their truth tables. [6 marks]

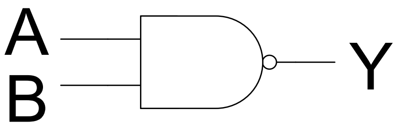
For example, the logic gate:



would correspond to the expression Y = A, and the truth table would be drawn:

A	Y
0	0
1	1

Logic Gate:



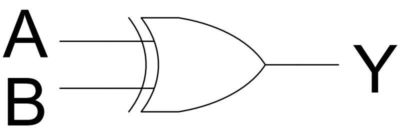
Logic expression:

Y = NOT (A AND B)   OR   Y = (AB)'   OR $Y = \overline{AB}$

Truth Table: Note the order of 0s and 1s for A and B

A	B	Y
0	0	1
0	1	1
1	0	1
1	1	0

Logic Gate:



Logic expression:

Y = A XOR B

Truth Table: Note the order of 0s and 1s for A and B

A	B	Y
0	0	0
0	1	1
1	0	1
1	1	0

Completion Section (for additional 15%)

Q4. Simplify the following expression using a Karnaugh map. [3 marks]

Y $= A.B.C + \bar{A}.\bar{B}.\bar{C} + \bar{A}.B.\bar{C} + A.B.\bar{C} + A.\bar{B}.\bar{C}$

$= 1.1.1 + 0.0.0 + 0.1.0 + 1.1.0 + 1.0.0$

First populate table:

		BC 00	01	11	10
A	0	1	0	0	1
	1	1	0	1	1

Then draw groupings:

		BC 00	01	11	10
A	0	1	0	0	1
	1	1	0	1	1

Simplified to $Y = ABC + \bar{C}$ OR $Y = ABC + \bar{C}$

Challenge Section (for additional 20%)

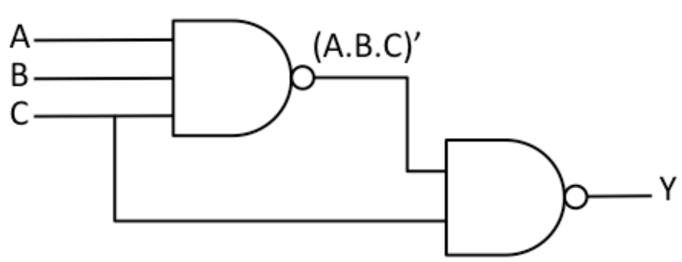
Q5. Draw the circuit diagram that implements the simplified expression from Q4 using only NAND gates. **Make sure to show your working** [4 marks]

Hint: You might want to use a dummy variable X for the intermediate steps, where:

$X = \overline{ABC}$ and therefore $\bar{X} = ABC$

You might then want to use De Morgan's rule: $\overline{(AB)} = \bar{A}+\bar{B}$

Y = A.B.C + C'
= X' + C'
= (X.C)'
= ((ABC)'.C)'



Part 2: Systems and Signals

<u>Core Section (for 65% of marks)</u>

Q6. Explain what is meant by a system and describe a real world example of a system. [4 marks]

You would have got 2 marks for something along the lines of:

- A set of things working together as parts of a mechanisms or an interconnected network.

And another 2 marks for any appropriate example, biological or mechanical.

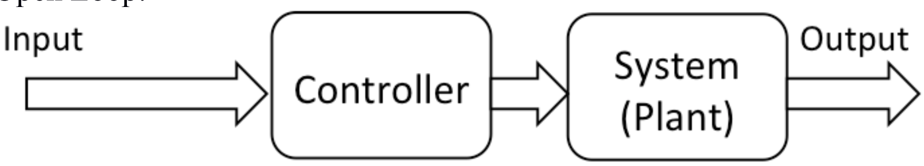
Q7. Why is it important to be able to model systems? [1 marks]

Full marks for something along the lines of:

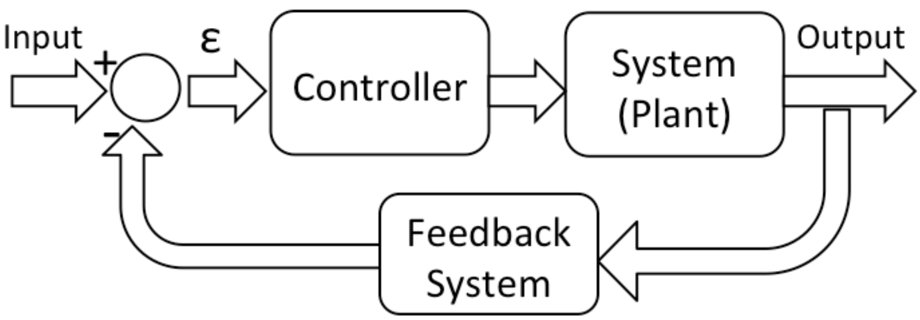
- To be able to understand it's behaviour under a variety of input conditions, so that potentially negative or dangerous situations can be avoided.

The following diagrams illustrate open loop and closed loop systems.

Open Loop:



Closed Loop:



Q8. State an example of one type of open loop system and one type of closed loop system. [4 marks]

Open loop:
See lecture notes for examples or do an Internet search

Closed loop:
See lecture notes for examples or do an Internet search

Q9. Note down one positive point and one negative point about each type of system. [4 marks]

Anything along the lines of:

	Open Loop	Closed Loop
Positive	Simple to implement	Accounts for changing conditions
Negative	Vulnerable to changing conditions	Increased complexity, or could become unstable

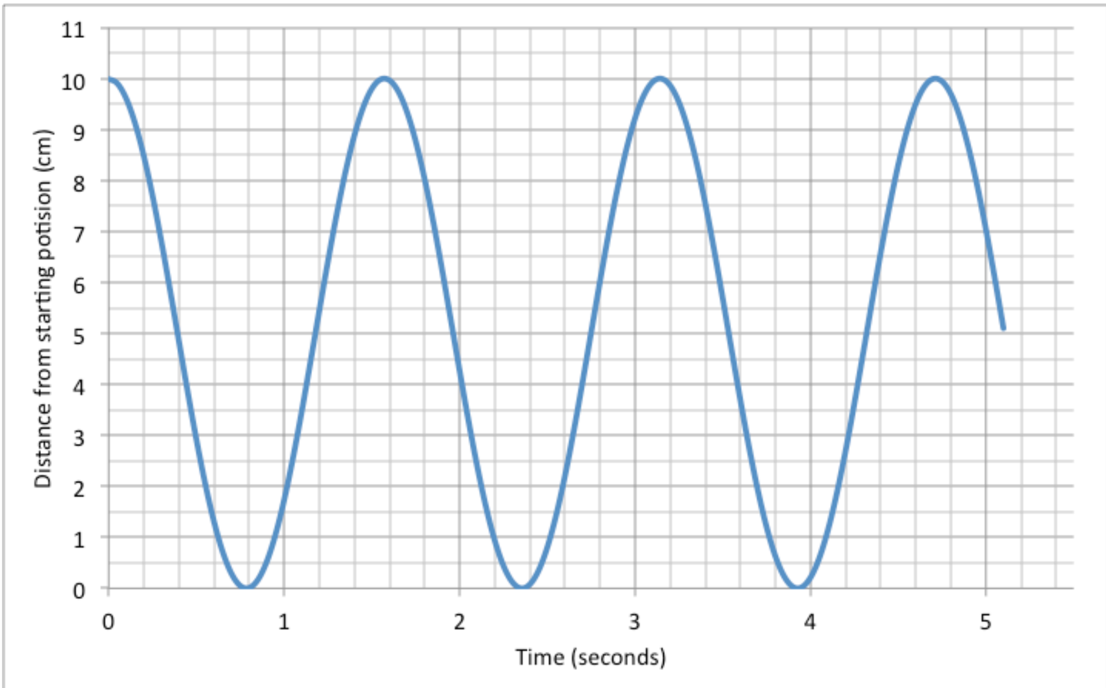
Completion Section (for additional 15%)

Q10. State the 4 key types of signals, which are distinguished from one another along the time and value dimensions and give an example of each. [3 marks]

Continuous in time (t), continuous in value (x) + example
Continuous in t, discrete in value x + example
Discrete in t, continuous in x + example
Discrete in t, discrete in x + example

<u>Challenge Section (for additional 20%)</u>

Q11. Convert the following signal from one that is observed in the real world to one that can be processed by digital electronics. First sample the signal at a 1 second interval, then perform quantization by rounding values to the closest cm, and finally encode by converting to binary numbers (assume 4 bit unsigned binary). **Make sure to show your working at each step.** [4 marks]



Step 1: sampling in time
Should have plot/table with (t,x) = (0,10), (1,~1.6), (2,~4), (3,~9.2), (4,~0.2), (5,7)
(Or indicate these values on plot above)

Step 2: quantizing
Should have plot/table with (t,x) = (0,10), (1,2), (2,4), (3,9), (4,0), (5,7)
(Or indicate these values on plot above)

Step 3: encoding
$10_{10} = 1010_2$; $2_{10} = 0010_2$; $4_{10} = 0100_2$; $9_{10} = 1001_2$; $0_{10} = 0000_2$; $7_{10} = 0111_2$

So you should have the following pulses:
t=0, pulse = 1010
t=1, pulse = 0010
t=2, pulse = 0100
t=3, pulse = 1001
t=4, pulse = 0000
t=5, pulse = 0111