

**Surname:**

**Other Names:**

**Student ID number:**

## **ENGR101 Engineering Technology**

**15<sup>th</sup> April 2016**

### **Instructions:**

Total time allowed 50 minutes

There are 60 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 20% of your final grade

Non-electronic translation dictionaries are permitted

Only silent non-programmable calculators or silent programmable calculators with their memories cleared are permitted in this examination.

### **Marking**

CORE (65%)	/ 28
COMPLETION (15%)	/ 16
CHALLENGE (20%)	/ 16
TOTAL:	/60

## Core Section (for 65% of marks)

### Q1. Converting between binary and decimal representations.

(i) Convert the following 8-bit unsigned binary numbers to decimal.

[2 marks]

(a) 0011 1100

(b) 1111 1101

(ii) Convert the following 8-bit 2's complement binary numbers to decimal.

[4 marks]

(a) 0011 1100

(b) 1111 1101

(iii) Convert the following decimal numbers to both unsigned and 2's complement binary numbers (where possible). Clearly show (or state) the number of bits required for each representation.

[4 marks]

(a) -25

(b) 1025

(iv) Calculate the number of bytes of memory required to store the variables in the following. C program. Show your working.

[2 marks]

```
#include <stdio.h>

int main(){
    char str = 'p';
    int a = 2;
    int b;

    b = 2a;
    printf("%s\n", str);

    return 0;
}
```

(v) Using binary we know how to store decimal numbers using binary digits. Explain how a letter (such as 'p' in the code above) can be stored using only 8 bits.

[2 marks]

**Question 2. Little Man Computer (LMC)**

(i) Explain the relationship between addressable memory and the program counter in the LMC cycle. Your answer should explain what both 'addressable memory' and the 'program counter' are in the LMC.

[3 marks]

(ii) Explain what an OpCode is and how they are used by the LMC.

[2 marks]

Listing 1: LMC Assembly code

---

```
INP
STO 6
ADD 6
OUT
HLT
a DAT 999
```

---

(iii) State the contents of memory addresses 5 and 6 after the assembly code in Listing 1 has been run by the LMC. Assume the value input is 12.

[4 marks]

**Question 3: Networking**

(i) Employees of an insurance company accessing company data on restricted local-area and wide-area networks is an example of using a(n)

- (a) Internet
- (b) BYOD Net
- (c) Intranet
- (d) Extranet

[1 mark]

(ii) List two reasons networking standards are used.

[4 marks]

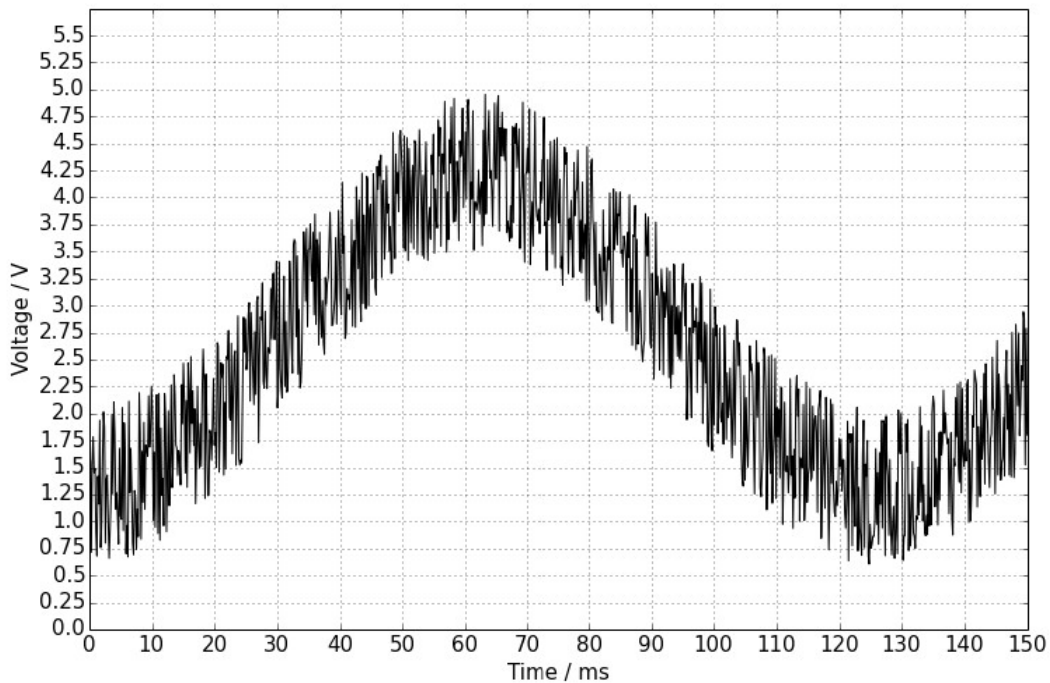
## **Completion Section (for 15% of marks)**

### **Question 4: Analog to Digital Conversion.**

In your AVC challenge you will use Raspberry Pis with an analog-to-digital converter attached to read information from the sensors.

(i) Why is the analog-to-digital converter necessary (i.e. why couldn't we connect analog sensors directly to the RPi)? Your answer should also define and explain what both an analog and a digital signal are and explain what the ADC does.

[3 marks]



(ii) The image above shows a signal produced by an IR sensor. Sketch (on the image) what the same signal would look like once it had been stored on the RPi (i.e. once it has been digitized by the ADC) if the ADC was 2-bit and sampled every 10 ms. Label your diagram so that each change from the original signal is clearly explained.

[5 marks]

(iii) By reading off the graph, estimate the signal-to-noise ratio of the analog signal shown above.

[2 marks]

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(iv) Sketch an example of an ideal, 5V digital signal.  
[2 marks]

(v) Use your sketch and the figure above to explain which type of signal (analog or digital) is more susceptible to errors from random noise and why.  
[4 marks]

## **Challenge Section (for 20% of marks)**

### **Question 5: Memory, Encoding and Data transfer**

(i) Estimate the amount of data (in bytes) contained within a 2 minute long Youtube video (without audio) by answering the questions below. The video is at 30 frames per second at a resolution of 640 x 360. Show all working.

[5 marks]

- (a) How many pixels are there per frame of the video?
  
  
  
  
  
  
  
  
  
  
- (b) How many bytes are required to store the data for one pixel, assuming RGB encoding?
  
  
  
  
  
  
  
  
  
  
- (c) What amount of data would be required to store this video if no compression was used?

(ii) Audio is encoded by a 16-bit ADC at 44.1kHz. Calculate how much extra data could this add to the above video file (if no compression was used).

[3 marks]

**Question 6: Engineering Ethics**

Earlier this year (2016) the American FBI and Apple Inc. entered a legal dispute when the FBI ordered Apple to update their operating system to enable the FBI to break into an iPhone. The iPhone in question belonged to a participant in a terrorist attack that injured 22 and killed 14 people in 2015.

- (a) Give examples for each of the following that have been raised by this case.
- An ethical issue involving engineering.
  - A societal impact of engineering technology.

[4 marks]

- (b) Outline what some of the ramifications (both positive and negative) of creating a security 'backdoor' for mobile devices may be. Then state whether YOU (personally) would be willing to create such a 'backdoor' or not and why.

[4 marks]