Surname:
Other Names:
Student ID number:

ENGR101 Engineering Technology
7 May 2019

Instructions:
• Total time allowed 50 minutes
• There are 62 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 15% 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.

Q1. Converting between binary and decimal representations [10 marks total]
(i) Convert the following 8-bit unsigned binary numbers to decimal
(a) 0010 0111 [1 mark]

(b) 1010 1010 [1 mark]

(ii) Convert the following decimal numbers into 8-bit unsigned binary
(a) 42 [1 mark]

(b) 251 [1 mark]

iii) Convert the following decimal numbers into hexadecimal:
(a) 14 [2 marks]

(b) 255 [2 marks]

(iii) Suppose you are working with numbers that range from 0 to 800. How many bits would be needed to represent these numbers in binary?
[2 marks]

Q2. RGB [14 marks total]

(i) Consider the standard 32 bit colour system. What range of values can the amounts of R, G, B, and Alpha Channel take and why? [2 marks]

(ii) Consider a much much lower quality image system in which R, G, and B are each represented by only three bits. There is no alpha channel in this system.
(a) What is the range of values for the amounts of R, G, B? [2 marks]

(b) How many different colours values can be represented by this system? [2 marks]

(iii) Explain how a digital camera works. Include discussion of light sensors and A/D converters as a minimum. [2 marks]

(iv) In a standard 32-bit colour system, what is the range of values for grey scale and why? [2 marks]

(v) Describe the appearance of a grey scale image produced from the following spreadsheet. Be specific about the shape of the image as a whole and any shapes in the image. [4 marks]

0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	255	255	255	255	255	255	255	255	255	255	0	0	0	0	0
0	0	0	0	0	255	255	255	255	255	255	255	255	255	255	0	0	0	0	0
0	0	0	0	0	255	255	255	255	255	255	255	255	255	255	0	0	0	0	0
0	0	0	0	0	255	255	255	255	255	255	255	255	255	255	0	0	0	0	0
0	0	0	0	0	255	255	255	255	255	255	255	255	255	255	0	0	0	0	0
0	0	0	0	0	255	255	255	255	255	255	255	255	255	255	0	0	0	0	0
0	0	0	0	0	255	255	255	255	255	255	255	255	255	255	0	0	0	0	0
0	0	0	0	0	255	255	255	255	255	255	255	255	255	255	0	0	0	0	0
0	0	0	0	0	255	255	255	255	255	255	255	255	255	255	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Q3. ADC and DAC [10 marks total]

(i) How many bytes of data are required to store an uncompressed 5 minute video clip with 30 frames per second, and a resolution of 1000 x 1000 pixels? [2 marks]

(ii) Human hearing works up to approximately 20,000 Hz. What is the minimum sample rate required to digitize sound at 20,000 Hz? [2 marks]

(iii) If you digitize too slowly the result is aliasing, the production of a signal at the wrong frequency. Sketch how this happens. Note the wrong frequency is lower than the true frequency. [2 marks]

(iv) Suppose you have a signal with frequencies up to 1000 Hz and high frequency noise at around 25,000 Hz. Given human hearing works up to 20,000 Hz:

(a) If you digitize this signal at 60,000 samples per second, will the noise produce audible effects (something you can hear)? [2 marks]

(b) If you digitize this signal at 40,000 samples per second, will the noise produce audible effects (something you can hear)? [2 marks]

Q4. Compression [8 marks total]

Describe the two kinds of data compression we have discussed:

(i) Lossless compression [2 marks]

(ii) Lossy compression [2 marks]

(iii) A engineer in Europe wants to send a file with random numbers to an engineer in New Zealand.

(b) Would lossless compression be effective? Explain. [2 marks]

(c) Would lossy compression be appropriate? Explain. [2 marks]

Q5. C++ programming [14 marks total]
(i) Is it sequence correct? Explain. [2 marks]
int num[6];
num[6] = 21;

```

```

(ii) Is it operator correct? Explain. [2 marks]
 int double a = 2.6;

```

```

(iii) What is the output of the code below. Explain. [4 marks]

```
#include <iostream>
using namespace std;
int main()
{
  int X=40;
  {
   int X=20;
   cout<<X<<endl;
   }
   cout<<X<<endl;
   return 0;
}
```

```

```

(iv) What is the output? [4 marks]
```
include<stdio.h>
int main()
{
   int a[5] = {5, 1, 15, 20, 25};
   int i, j, m;
   i = a[1];
   j = a[1] + 1;
   i=i+1;
   m = a[i];
   cout<<"i="<<i<<" j="<<j<<" m="<<m<<endl;
   return 0;
}
```

(v) What would the following code do? Hint: it may not work the coder hoped! [2 marks]
```
int main ()
{
int total = 0;
while(count1<100)
        {
                while(count2<200)
                {
                        total = total + count1 + count2;
                }
        }
count1++;
}
```

Q6. Computer Organization [6 marks total]

(i) What does "word" mean in terms of computer memory? [1 mark]

(ii) What is the difference between von Newman and Harvard architecture? [2 marks]

(iii) What does a compiler take as an input and what does it produce as an output? [1 mark]

(iv) How many memory locations can be used if the width of the address bus is 8 bits? [2 marks]