TE WHARE WĀNANGA O TE ŪPOKO O TE IKA A MĀUI

VICTORIA
UNIVERSITY OF WELLINGTON

EXAMINATIONS — 2008
MID-YEAR

ENGR101

ENGINEERING

TECHNOLOGY

Time allowed: THREE HOURS

Instructions: You must answer **ALL** questions

Marks for each question are shown.

There is an appendix at the end of the paper.

The exam consists of 150 marks in total.

Paper foreign to English language dictionaries are allowed.

Calculators are permitted.

Electronic dictionaries are not allowed.

1. ADC and DAC (6 marks)

(a) 14-bit digital data will be converted to analogue data by a DAC. If the range of the signal is to be 0 to 10 volts, what will be the voltage resolution?

[3 marks]

(b) If the digital to analogue conversion rate (sample rate) is 22,050 samples per second, can you make an analogue signal with a frequency of 10,000 Hz? 15000 Hz? Explain.

[3 marks.]

2. Binary Numbers (6 marks)

(a) Add the binary numbers 10010011 and 10110011.

[3 marks]

(b) The numbers in question 2(b) are 8 bit numbers. Let's suppose they are U8 (unsigned 8 bit) in LabVIEW. What would happen if you added them? How could you prevent this problem?
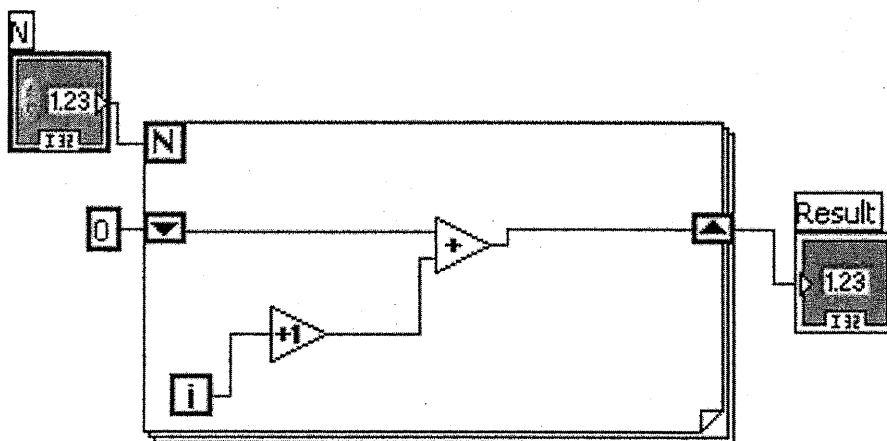
[3 marks]

3. LabVIEW (6 marks)

(a) What are the missing words in the following sentence? The user interface in a virtual instrument is called the _____ while the code resides on the _____ .

[2 marks]

(b) What does the program below do? Explain briefly how it works.

[4 marks]

4. Image technology (12 marks)

(a) Explain how RGB displays can fool the eye into seeing colour that are not present.

[3 marks]

(b) How many different colours could be represented if the amounts of red, green, and blue data are each represented by 4 bits?

[3 marks]

(c) A 2-hour movie is to be displayed at a distance of 25 cm on a hand-held display device that is 30 cm wide and 20 cm tall.

(i) How many pixels are needed on the screen to make individual pixels too small to resolve? Assume the resolution of the human eye is 3x10-4 radians.

[3 marks]

(ii) If the movie is to be displayed at 25 frames per second with 24 bit colour depth, and the sound that goes with the movie is 16 bit, stereo, 44,100 samples per second, how many bytes of data storage will be needed if the movie is stored in raw form?

[3 marks]

5. Data Compression (10 marks)

(a) An inventor tells you he can recover original quality images from a low-quality jpg you email to him. Do you believe him? Explain.

[3 marks]

(b) Consider the data stream below. Develop a lossless compression scheme using pairs of bits that will result in a reduction in the file size. Do not actually compress the data stream.
10111011110100011101110011110111110

[4 marks]

(c) Under what conditions will lossless data compression work well (reduce the file size substantially)? Explain.
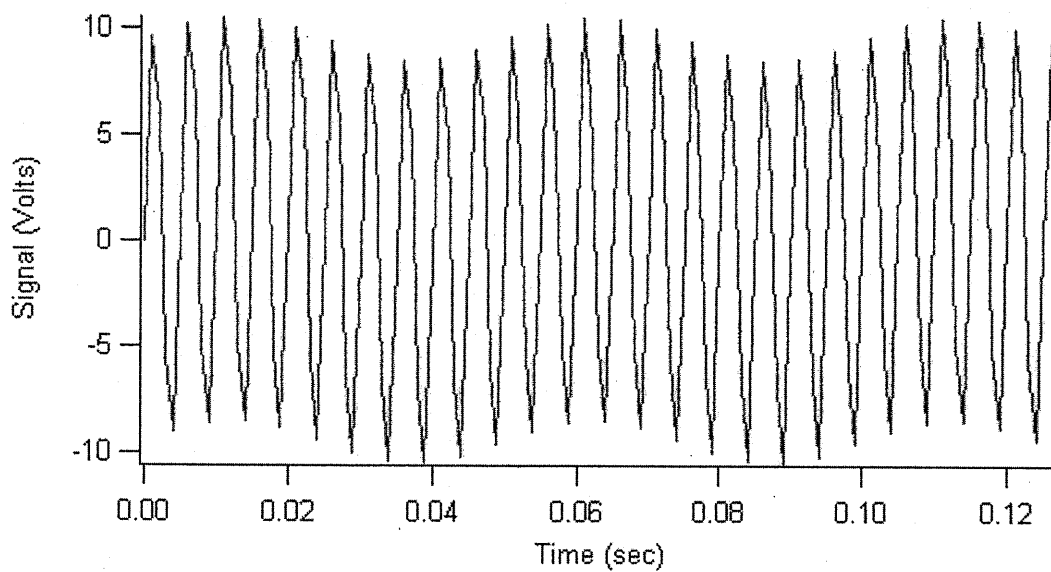
[3 marks]

6. Waves (10 marks)

(i) Consider an electromagnetic wave that contains frequency components from 101 MHz to 102 MHz. Does this signal also contain a range of wavelengths? If so, what is the range? The speed of EM waves is 3x108 ms-1.

[5 marks]

(ii) Sketch a power spectrum for the signal below.

[5 marks]

7. Hardware (25 marks)

(a) Briefly describe each of the following and their tasks: (1) Motherboard; (2) CPU socket; and, (3) Heatsink.

[5 marks]

(b) Describe what happens when a sector of a hard drive is read.

[5 marks]

(c) Explain why a PC with a large L2 cache may sometimes execute a program faster than a PC with a small L2 cache.

[5 marks]

(d) Adam has bought a new computer and is running several large programs at once that he often switches between. His hard drive light is winking all the time and there is a noticeable pause when he switches between programs. Can you explain what is going on?

[5 marks]

(e) Carol wants to buy a new laptop, mainly for playing games. Zebedee Computers is selling a new laptop that they describe as being benchmarked as running programs faster than their competitor's laptop. Given they are the same price, would you recommend that Carol buys the Zebedee Computers laptop?

[5 marks]

8. Software (25 marks)

(a) Define the functions of the following components of a CPU: (1) registers; (2) arithmetic-logic unit; and, (3) control unit.

[5 marks]

(b) Adam claims that there is always a one-to-one relationship between assembly language and machine code. Discuss whether he is right or wrong.

[5 marks]

(c) Why do modern computers store programs in the same place as its data instead of having separate memory for programs? Are there any problems with this approach?

[5 marks]

(d) Write an assembly language program using the Knob and Switch assembly language (see Appendix) that is equivalent to the following line of Java (assume a is stored in memory location 20, b in memory location 21, c should be stored in memory location 22 and memory location 23 holds the value 1):

```
int c = a * b;
```

[10 marks]

9.   **Operating Systems (25 marks)**

(a) What happens when an operating system is booted?

[5 marks]

(b) Would you choose polling or interrupts to interact with a device measuring an infrequently changing value? Justify your decision.

[5 marks]

(c) Dave is a designer for a mobile phone manufacturer. Discuss why Dave might want to choose a post-GUI interface such as used by the iPhone over a WIMP interface such as Windows.

[5 marks]

(d) Eve is the lead designer for a new operating system for a range of mobile phones. The mobile phones differ greatly in terms of the amount of RAM and ROM that they have as well as features such as support for networking. Her first decision is whether to go for a monolithic versus modular design. What is your recommendation based upon the constraints outlined above?

[5 marks]

(e) What motivated the development of multiuser operating systems in the 1960s?

[5 marks]

10.   Internet (25 marks)

(a) Your friend Fraser has started a new job and texts you that his new company has a **LAN** with a **daisy chain topology**. What do these two terms mean? Why did his neighbour get angry when Fraser accidentally cut the network cable running through his cubicle?

[5 marks]

(b) Many medical practices store patient data on their own local computers. Keeping in mind what was discussed in lectures, what would be the advantages and disadvantages of connecting all medical practices to a shared network?

[5 marks]

(c) You want to transmit related video and audio data over the same communication link. Would you recommend sending the data as two separate streams or as packets? Justify your answer.

[5 marks]

(d) Define the function of each of the following network protocol layers: (1) Data link; (2) Network; and, (3) Transport.

[5 marks]

(e) Gina is running a web server on her LAN that she does not want to be accessible from the outside even though her LAN is connected via a router to the Internet. How would using a firewall help protect her web server? Describe how the firewall would discriminate between packets.

[5 marks]

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APPENDIX: ASSEMBLY
LANGUAGE INSTRUCTIONS

Data Movement Instructions:	Example:	Meaning:
LOAD [REG] [MEM]	LOAD R2 13	R2 = M[13]
STORE [MEM] [REG]	STORE 8 R3	M[8] = R3
MOVE [REG1] [REG2]	MOVE R2 R0	R2 = R0
Arithmetic and Logic Instructions:	Example:	Meaning:
ADD [REG1] [REG2] [REG3]	ADD R3 R2 R1	R3 = R2 + R1
SUB [REG1] [REG2] [REG3]	SUB R3 R1 R0	R3 = R1 - R0
AND [REG1] [REG2] [REG3]	AND R0 R3 R1	R0 = R3 & R1
OR [REG1] [REG2] [REG3]	OR R2 R2 R3	R2 = R2 I R3
Branching Instructions:	Example:	Meaning:
BRANCH [MEM]	BRANCH 10	PC = 10
BZERO [MEM]	BZERO 2	PC = 2 IF ALU RESULT IS ZERO
BNEG [MEM]	BNEG 7	PC = 7 IF ALU RESULT IS NEGATIVE
Other Instructions:	Example:	Meaning:
NOP	NOP	Do nothing.
HALT	HALT	Halt the machine.