Study Period 4, 2020 - CPT160

Introduction to Computer Systems and Platform Technologies

Assignment 1 – Worth 25% (250 marks)

Due: 23:59 (AEST) on Sunday, 17'th January, 2021, Week 7

Note: Citations / References / Bibliography 10 marks

Some questions of this assignment require independent research. All references used (books, websites, etc.) must be disclosed in your submission. This may be done either through providing citations throughout your work, or by including a list of references / bibliography at the end of the document. Read and follow all the instructions carefully. Failure to do so is not grounds for extensions.

Plagiarism:

This is an individual assignment and must be your own work. Plagiarism is a very serious offence. **All assignments will be checked with plagiarism-detection software**

Plagiarism in oral, written or visual presentations is the presentation of the work, idea or creation of another person, without appropriate referencing, as though it's one's own. Plagiarism is not acceptable and may result in charges of academic misconduct, which carries a range of penalties. It is also a disciplinary offence for students to allow their work to be plagiarised by another student.

Research, Collaboration and Academic Integrity

There is a research component to this assignment:

- Any direct references, figures, or quotes used must be cited, and
- A bibliography should be included as an appendix at the end of your report.

We will not accept citations from any encyclopaedic resource; e.g. Encyclopaedia Britannica, Encarta, World Book, Wikipedia (or syndication thereof), and so on.

You may share and discuss any links and references you find relevant to completing this assignment on the discussion forums, so long as you include how you found the resource that you mention.

You are free to refer to textbooks, notes, work in study groups etc. to discover approaches to problems; however, the assignment should be your own individual work.

Do not ever simply copy and paste what another writer has written. This is stealing. What we need is your own words – your own understanding. If you try to represent someone else's work as your own it will be dealt with severely. Instead, we want you to paraphrase what others have said – to put the concepts they have discussed into your own words.

When preparing a report such as this it is almost impossible to prepare an accurate report without referring to some resources for assistance to complete the tasks. For this reason, we ask you to reference from where you get your information. We require these references to be formally correct according to one of the standard styles used in research. For example, either the APA or Harvard styles would be acceptable. See the RMIT library reference guides (https://www.rmit.edu.au/library/study/referencing) for further details.

Let us say that I want to use the ideas in the following paragraph to explain bit depth as it relates to images:

> *"Bit depth refers to the colour information stored in an image. The higher the bit depth of an image, the more colours it can store. The simplest image, a 1-bit image, can only show two colours, black and white. That is because the 1 bit can only store one of two values, 0 (white) and 1 (black). An 8-bit image can store 256 possible colours, while a 24-bit image can display about 16 million colours."*

The above paragraph was taken from the website:
http://etc.usf.edu/techease/win/images/what-is-bit-depth/

The first step might be to paraphrase the information about – that is to put the information above into your own words, such as:

> *Bit depth signifies how many colours that can be represented in an image – the more bits per pixel the wider the range of colours (Techease, 2020)*

This would then be cited in your reference list as:

Techease, 2020, "What is bit depth?" Retrieved from http://etc.usf.edu/techease/win/images/what-is-bit-depth/ at 7 pm on Saturday 11th July, 2020.
You would reference this citation similarly in the bibliography.

Please note that we require you to have both a reference list and a bibliography. The difference between these two resources is that the bibliography lists all documents that you have read that have contributed to your submission whereas the reference list only lists those documents you have actually cited in the text of your report.
Also, with the exception of very short quotes (less than a line) we require you to put the content in your own words – we are assessing you on your understanding of the course content, after all. If you quote directly from a source, please ensure that the quote is within "talking marks" such as the ones I have just used. Whether you quote directly from a source or paraphrase the source (as I have done above) you still need to cite the source and ensure the source is included in the reference list and bibliography.

Extensions:

If you want to seek an extension of time for assignment submission, you must have a substantial reason for that, such as unexpected circumstances. Reasons such as, unable to cope with study load, is not substantial.

Also, you must apply for an extension as soon as possible. Last minute extensions cannot be granted unless it attracts special consideration

Any student wishing an extension must go through the official procedure for applying for extensions and must apply at least a week before the due date Do not wait till the submission due date to apply
for an extension.

Submission:

Prepare the answers to this assignment in an electronic format and convert to a single Acrobat PDF (.pdf) file for submission. Paper submissions are not accepted; if some parts of the assignment have been completed by hand, scan these in and include this in your electronic submission.

This assignment must be submitted electronically via Canvas. Further instructions are at the end of this document.

Penalties:

Submission files not in the required format will incur. a penalty of 10% per day of the total available marks will apply for each day being late. After 5 days, you will receive zero mark for the assignment.

Task 1 - Number Systems (30 marks)

Give answer to the following questions (show all your working out and intermediate steps).

a) (5 marks) Convert your RMIT student number (e.g. '3212345') from decimal to binary.

b) (2+3 marks) Convert the binary string of your RMIT student number to octal and hexadecimal.

c) (5 marks) Convert your RMIT student number to base 13, where A , B and C correspond to 10, 11 and 12 respectively.

d) (3 +2 marks) Now add 39_{10} to your RMIT student number, answer the same question as in (c).

How many digits are different from the answer in (c)? Why was this easy to calculate?

e) (10 marks) Consider a base 26 number system wherein the letters of the alphabet are the digits.

That is, **A=0, B=1, C=2, … Z=25** in base 10.
Use **the first 2 letters** of your given name as a number in the base 26 system, and the **first three letters** of your surname as another number in the base 26 system.

Add these numbers together to obtain the sum in based 26.
Note:
If your given name has letters less than two letters, repeat the first letter (e.g. L becomes LL).
Then a similar way is applied for your surname.

Example 1 — if your first name is "Peter" and your surname is "Pan", then add up PE_{26} *and* PAN_{26}*, and show the sum in base 26.*
Example 2 — if your first name is "Peter" and your surname is "Pa", then add up PE_{26} *and* PAA_{26}*, and show the sum in base 26.*

Task 2 - Binary Addition and Subtraction (25 marks)

Please answer the following questions**, showing all your working out and intermediate steps**. For this question, use the last two digits of your student number. (For example, if your student number is "s1234567", then A=7 and B=6)
If either of these digits is a "0", use 9 instead.
If A and B are the same add 1 to B.

a) (10 marks) Convert the decimal numbers A and B to 4-bit binary numbers. Show how to add together these two 4-bit binary numbers and state whether the answer is valid to 4-bit arithmetic.

b) (15 = 10+5 marks) Convert the decimal numbers A and B to 6-bit binary numbers. Using two's complement representation, show how to:

i. Subtract the two 6-bit binary numbers (-A-B)

ii. Translate the binary result back to decimal.
(Note if your solution is negative you must use 2's complement to show the positive equivalent)

Task 3 - Bitwise Operations (20 marks)

The bitwise operator（AND, OR, and XOR） are used to do bit-masking; that is,

- *set* (make 1), *reset* (make 0), *invert(toggle or flip)* (from 0 to 1, or from 1 to 0) a bit (or bits) in a byte (or word).
- *Bit masks* are strings of bits that allow for a single bitwise operation on a bit (or bits).

Commonly a bit string is 8 bits long (referred to as a *byte*). Conventionally, the bits in a bit string are indexed from 0 staring with LSB. Let A = XXXX $XXXX_2$, where each X is a unique bit (0 or 1).

Byte A	X	X	X	X	X	X	X	X
Bit Position	7	6	5	4	3	2	1	0

For bit-wise operations, let us consider a bit string, e.g., A = 1111 0000_2. We will number these bit from 0 to 7, starting from LSB. Now, suppose we want to ensure that bit 7 in A is reset (i.e., made 0).

All the other bits are left untouched. For this purpose, we now must first create a bit-mask M and select an appropriate bitwise operator O. In this example, we create our mask M as 0111 1111 and select the bitwise operator O as AND. Now we perform the operation:

A AND M = 1111 0000_2 AND 0111 1111_2 = 0111 0000_2

Solve the following problems by finding the appropriate bitmask M and bitwise operator O**. You can also choose more than one mask and operator, such as M1, O1 and M2, O2.**
Show all your working out and intermediate steps and use A = XXXX $XXXX_2$ with your mask(s) and operator(s):

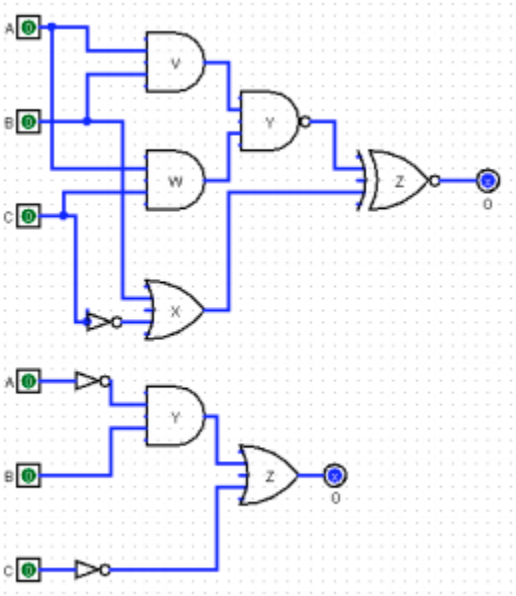
a) (4 marks) Set bit 0, bit 7 and leave the rest untouched.

b) (8 marks) Make sure that bit 1 and bit 6, and only these, are reset, the others are set.

c) (8 marks) Toggle the values of the middle 4 bits (the opposite of what they are currently), and set the 2 bits on each side.

Task 4 - Logic Circuits and Truth Tables (30 marks)

Solve problems related to the two circuits (note the circle is equivalent to a NOT gate) below:
Circuit 1 is the top circuit and Circuit 2 is the bottom one.



(a) (6+4 = 10 marks) Write down the equivalent logic expression (simplification is NOT required).

(b) (11+7 =18 marks) Write a truth table that shows the final output (O) for inputs A, B and C (Showing all your working out and intermediate steps, i.e., the output of each gate, in the truth table is a column).

(c) (2 marks) Compare the final output columns in these two truth tables. Do these two expressions give the same output?
Hence, are the 2 expressions equivalent?

Task 5 - Pipelining (10+10 = 20 marks)

Question 1

Consider the following example of instruction stage pipelining that illustrates the advantage of a deeply pipelined processor. For example, suppose a processor uses an 8 stage pipeline that uses three clock ticks for each stage and another processor design uses a 20 stage pipeline that does very simple things at each stage and only requires one clock tick for every stage.

a. (3+3= 6 marks)

   i) For each processor, how many clock ticks some it take to fill the pipeline?

   ii) Given that each pipeline is full, and given 30 clock cycles, how many instructions can be executed for each processor?

Marks are awarded for your working out and calculations.

b. (4 marks) Describe 4 disadvantages of using a "deeply pipelined processor".

Question 2 (10 marks) Pipelining and Speculative Branching Prediction.

Assume a CPU has a 4-stage pipeline (i.e. stages for Fetch, Decode, Execute, Store) and each stage takes 1 clock cycle.

Assume instruction A is a WHILE LOOP test, and instructions B, C, D are inside the WHILE loop block and have been speculatively loaded into the pipeline. But on executing A, the processor discovers the loop will terminate so B, C, D should not be performed. Draw the pipeline for the next 6 clock cycles.

Task 6 – CPU Architecture (20 marks)

Please explain in your own words for each part of Question 6. Do not "copy and paste" from the "Internet". Quote your references in your "References" / "Bibliography"

(a)

1. (8 marks)) Compare and contrast "multithreading" and "multiprocessing" in terms of hardware.

2. (7 marks) Explain how threads are used by the CPU to process tasks by describing a modern example, e.g., the multi-core mobile phone that you use every day has an interesting organisation of threads.
However, it can be any other modern example of hardware that uses "threads".

3. (5 marks) There are a number of techniques used by CPU designers to improve the performance of their processors. However, these optimisation strategies do not always work – for some workloads, they may have no effect, or even cause performance to degrade.

What is a circumstance where simultaneous multi-threading (S.M.T.) cannot offer any advantage, or possibly even cause a performance decrease

Task 7 - Memory (5 +5 + 5 +5 = 20 marks)
Please explain in your own words for each part of Question 7. Do not "copy and paste" from the "Internet". Quote your references in your "References" / "Bibliography"

(a) What are the maximum clocks speeds for GDDR5 memory, and GDDR6.

(b) What is the current maximum throughput available for GDDR5 and GDDR6.

(c) i) Find the bus sizes of DDR5 6400 MHz and GDDR6.
ii) Explain why the sizes are quite different.

(d) i) HBM stands for ***High Bandwidth Memory*** that is manufactured by Hynix and Samsung.. Explain in your words the different in memory architecture between HDM and GDRR6.
ii) What is the size of HDM bus? Does this give HBM any advantage?

Task 8 - Hamming & SECDED Code (5+20= 25 marks)

(a) (5 marks) For data, using 4 Hamming code parity bits determine the maximum number of data bits that can be protected.

(b) A SECDED encoded character has been retrieved, with the hexadecimal value of $51A_{16}$. **You may assume that the SECDED parity is even.**

1. (1 + 4 marks) Was there an error in transmission? Explain your answer.

2. (15 marks) If there was an error, either correct it (reporting the corrected ASCII character) or explain why it could not be corrected **(Show your Hamming/SECDED table).**

Advanced Questions (50 marks)

Question 9 — Advanced Question (50 marks) You need to attempt either 9.1 or 9.2 to be eligible for an **HD** for this assignment, **NOT BOTH**

Note: The specifics of these questions have not been covered in lectures. It tests your ability to do independent research, as well as apply the concepts and ideas you have learned to a new situation. Please explain in your own words for each question. Do not "copy and paste" from the "Internet". Do not forget to cite your references.

Question 9.1 Half-precision Floating-point Format (50 marks)

Do some research and find out how real (floating point) numbers are represented in Binary.

(a) (10 =6+4 marks) **Devise your own 16-bit representation** for floating point numbers. Draw a diagram of your representation and explain what the various bits are used for.
Explain in detail:
(i) How many bits are allocated to the mantissa and the exponent, respectively?

(ii) What defines the range and the precision (or accuracy) of the numbers stored in floating point notation?

(b) (5+10+10 +(4+5)=34 marks)

If your student number is "s1234567", then
A=7 and B=6

x = A + B/10 = 7 + 6/10 = 7.6

y=B÷(A×10) = 6÷(7×10) = 0.0857 (rounded to 4 decimal places)

If either of these digits is a "0", use 9 instead.
If both of these digits are the same, use B = A-1. .

Show in detail:

(i) How x and y would be represented using your 16-bit representation.

(ii), The various steps needed to add together the two numbers x and y in binary.

(iii) The steps needed to convert the binary result obtained to decimal.

(iv) Did you lose precision/accuracy through addition? Discuss what is causing this "loss of precision" error.

(c) (6 marks) When adding up a large number of floating point numbers, in what order should they be added together to get the most accurate result? Explain why with an example.

Question 9.2 — Logic Simplification using Karnaugh Maps and Boolean Algebra (50 marks)

Do some research and find out how a Karnaugh map is used for reducing logic functions into minimal Boolean expressions.

a) (20 marks) Show in detail, how to use the K-map to simplify the logic expression of **circuit 1 in Question 4**.

b) (20 marks) Show in detail, how to use Boolean Algebra to simplify the logic expression **of circuit 1 in Question 4**.

c) (5 marks) Compare the above two simplification methods and discuss which is better: Boolean algebra or K-map?

d) (5 marks) What are the limitations of Karnaugh Maps? Explain with an example.

How to Submit

You should submit your assignment via Canvas using the

Assignments > Assignment 1 Submission.

You may resubmit the assignment if you need to, only the most recent version will be marked.
(Note do not forget to submit references/bibliography at the end of your submission)