CS1021 Tutorial #1
Information Storage Units, Numeral Systems and Basic Assembly Language

1 Units of Information Storage

(a) Calculate the number of:

(i) Bytes in 1KiB

(ii) Bytes in 1MiB

(iii) Bytes in 4.5MiB

(iv) Bits in 16MiB

(b) If an integer value is stored in memory as a 4-byte binary value, how many integers can be stored in:

(i) 1KiB

(ii) 1MiB

(iii) 1022 bytes

(c) A digital image is 640 pixels wide by 480 pixels high. The colour of each pixel is encoded as a 24-bit value. The image is not compressed. How much memory is required (in bytes) to store the image in memory. How much memory is required in KiB?

2 Numeral Systems

(a) How many unique values can be represented using a binary numeral system with:

(i) 4 bits

(ii) 7 bits

(iii) 12 bits

(b) How many unique values can be represented using a hexadecimal numeral system with:

(i) 1 digit

(ii) 4 digits

(iii) 6 digits

(c) How many unique values can be represented using a ternary (base 3) numeral system with:

(i) 2 digits

(ii) 5 digits

(iii) 7 digits

(d) Assuming the ARM architecture definition of the word and halfword units of storage, calculate:

(i) the number of unique values that can be stored in a halfword

(ii) the range of non-negative integers that can be stored in a halfword

(iii) the number of unique values that can be stored in a word

(iv) the range of non-negative integers that can be stored in a word

(e) Convert the following binary numbers into their decimal equivalents:

(i) 1010

(ii) 10100110

(iii) 11111111

(iv) 10000000

(f) Convert the following decimal numbers into their binary equivalents:

(i) 9

(ii) 64

(iii) 63

(g) Convert the following binary numbers into their hexadecimal equivalents:

(i) 0111

(ii) 1010

(iii) 10011100

(iv) 100110

(h) Convert the following hexadecimal numbers into their binary equivalents:

(i) 0xFFFF

(ii) 0xA08C

(iii) 0x4F1E080C

(i) How many binary digits are required to store the equivalent of the following decimal values?

(i) 620

(ii) 1600

3 Memory Addresses

If one hundred integers are stored consecutively in memory beginning at address 0x2000 (2000_{16}) and if each integer requires one word of storage, what will be the address of the word containing the 22^{nd} integer?

4 ARM Assembly Language

In the exercises below, assume that x is a value stored in R1 and y is a value stored in R2.

(a) Provide an ARM Assembly Language instruction to store $x + y$ in R0.

(b) Provide an ARM Assembly Language instruction to store $y - x$ in R0.

(c) Provide an ARM Assembly Language instruction to store x^2 in R0.

(d) Write an ARM Assembly Langauge program to evaluate $5y$, storing the result in R0.

(e) Write an ARM Assembly Langauge program to evaluate $3x + y$, storing the result in R0.

(f) Write an ARM Assembly Langauge program to evaluate $3x^2 + 5x$, storing the result in R0.

(g) Write an ARM Assembly Langauge program to evaluate $2x^2 + 6xy + 3y^2$, storing the result in R0.

(h) Write an ARM Assembly Langauge program to evaluate $x^3 - 4x^2 + 3x + 8$, storing the result in R0.

You may find the following ARM Assembly Language instructions useful:

MOV Rd, Rm Move (or copy) the value from Rm into Rd

LDR Rd, =x Load the value x into Rd

ADD Rd, Rn, Rm Add Rm to Rn, storing the result in Rd

SUB Rd, Rn, Rm Subtract Rm from Rn, storing the result in Rd

MUL Rd, Rn, Rm Multiply Rn by Rm, storing the result in Rd (Note: Rd and Rn cannot be the same)