CS1021 Tutorial #2 Solution
Machine Code and Binary Arithmetic

1 Machine Code

(a) `0xE0850005`
`0xE0800005`
`0xE1A08007`
`0xE0877000`
`0xE1A09007`

(b) `ADD R5, R6, R8`

(c) 0xE0965008

2 Addition of Binary Numbers

(a) 1111

(b) 1000

(c) 10010

(d) 100010100

3 Subtraction of Binary Numbers

(a) 100

(b) 101

4 Multiplication of Binary Numbers

(a) (i) 100011

(ii) 10001111000

(b) Require $2n$ bits to store the result of the multiplication of two n-bit numbers

5 Modulo Arithmetic

(a) 5 (0101)

(b) 1 (0001)

(c) 6 (0110)

6 2's Complement

(a) (i) $(-2^{8-1}) \dots 0 \dots (+2^{8-1}-1)$ *(or* $-128 \dots 0 \dots +127$*)*

(ii) $(-2^{32-1}) \dots 0 \dots (+2^{32-1}-1)$ *(or* $-2,147,483,648 \dots 0 \dots +2,147,483,647$*)*

(b) (i) 0000 0000

(ii) 0000 0100

(iii) 1111 1100

(iv) 1110 0101

(c) (i) 0000 0000 (0_{10})

(ii) 1111 0110 (-10_{10})

(iii) 0000 0101 ($+5_{10}$)

(iv) 1000 0000 (-128_{10} – incorrect result – "overflow"!!)

7 64-bit and 128-bit Arithmetic

(a) 64-bit addition

```
1    ADDS    R1, R3, R5
2    ADC R0, R2, R4
```

(b) 128-bit addition.

```
1    ADDS    R3, R11, R7
2    ADCS    R2, R10, R6
3    ADCS    R1, R9, R5
4    ADC R0, R8, R4
```

(c) 64-bit subtraction.

```
1    SUBS    R1, R3, R5
2    SBC R0, R2, R4
```