Mathematics for Software Development

BSc (Hons) Computer Games Programming

School of Engineering, Arts, Science and Technology

Answer all of the following questions, showing all of your working. Use extra sheets of paper if required (graph or squared paper may be used).

**To be completed by 09:00 Monday 8th February 2021**

Student ID …………………………………..

This problem set has 8 questions, for a total of 100 points.

Marks Awarded:

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Question** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **Total** |
| **Marks Available** | **10** | **10** | **10** | **10** | **10** | **10** | **15** | **25** | **100** |
| **Score** |  |  |  |  |  |  |  |  |  |

Question 1

Convert the following decimal values (base 10) into binary (base 2), show working out. Answer in space provided. [2 points each part]

1. 15

|  |  |
| --- | --- |
|  | |
|  | |
| Answer |  |

1. 48

|  |  |
| --- | --- |
|  | |
|  | |
| Answer |  |

1. 96

|  |  |
| --- | --- |
|  | |
|  | |
| Answer |  |

1. 113

|  |  |
| --- | --- |
|  | |
|  | |
| Answer |  |

1. 251

|  |  |
| --- | --- |
|  | |
|  | |
| Answer |  |

Points awarded: \_\_\_\_\_\_\_\_\_ out of a possible 10.

Question 2

Convert the following 8-bit binary values (base 2) into decimal (base 10), show working out. Answer in space provided. [2 points each part]

1. 00011011

|  |  |
| --- | --- |
|  | |
|  | |
| Answer |  |

1. 01100110

|  |  |
| --- | --- |
|  | |
|  | |
| Answer |  |

1. 01111001

|  |  |
| --- | --- |
|  | |
|  | |
| Answer |  |

1. 10101010

|  |  |
| --- | --- |
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| Answer |  |

1. 11100111

|  |  |
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| Answer |  |

Points awarded: \_\_\_\_\_\_\_\_\_ out of a possible 10.

Question 3

Complete the following table. [2 points]

|  |  |
| --- | --- |
| **Binary** | **Hexadecimal** |
| 0000 | 0 |
| 0001 | 1 |
| 0010 | 2 |
| 0011 | 3 |
| 0100 | 4 |
| 0101 | 5 |
| 0110 | 6 |
| 0111 | 7 |
| 1000 | 8 |
| 1001 | 9 |
| 1010 |  |
| 1011 |  |
|  |  |
|  |  |
|  |  |
| 1111 | F |

Hence convert the following hexadecimal values into binary. [2 points each part]

1. BC

|  |  |
| --- | --- |
| Answer |  |

1. DE

|  |  |
| --- | --- |
| Answer |  |

1. A2

|  |  |
| --- | --- |
| Answer |  |

1. 95

|  |  |
| --- | --- |
| Answer |  |

Points awarded: \_\_\_\_\_\_\_\_\_ out of a possible 10.

Question 4

Consider the following 8-bit binary value 10001111. What is its decimal value if the format of the data is as follows, show working out. [2 points each part]

1. Unsigned binary

|  |  |
| --- | --- |
|  | |
|  | |
| Answer |  |

1. Sign and magnitude

|  |  |
| --- | --- |
|  | |
|  | |
| Answer |  |

1. 2’s complement

|  |  |
| --- | --- |
|  | |
|  | |
| Answer |  |

1. Find the 2’s complement of the following 32-bit binary value 0111 0001 0000 1111 1010 0101 1100 0010

|  |  |
| --- | --- |
| (leave answer in binary) | |
|  | |
| Answer |  |

1. Explain what is meant by an “overflow error”.

|  |  |
| --- | --- |
|  | |
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Points awarded: \_\_\_\_\_\_\_\_\_ out of a possible 10.

Question 5

Calculate the following 8-bit binary additions, show working out. Indicate if there is a Carry Over. [2 points each part]



|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 |
|  | + | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 0 |
|  |  |  |  |  |  |  |  |  |  |



|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 |
|  | + | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 |
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|  |  | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 |
|  | + | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 |
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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 |
|  | + | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 0 |
|  |  |  |  |  |  |  |  |  |  |



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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 |
|  | + | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 |
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Points awarded: \_\_\_\_\_\_\_\_\_ out of a possible 10.

Question 6

Calculate the following 8-bit binary subtractions, show working out.

[2 points each part]



|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 |
|  | - | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 |
|  |  |  |  |  |  |  |  |  |  |



|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 1 |
|  | - | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 |
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|  |  | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 1 |
|  | - | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 1 |
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|  |  | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 |
|  | - | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 |
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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 1 |
|  | - | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 1 |
|  |  |  |  |  |  |  |  |  |  |

Points awarded: \_\_\_\_\_\_\_\_\_ out of a possible 10.

Question 7

Calculate the following 8-bit binary multiplications, show working out.

[5 points each part]



|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 |
|  | x | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
|  |  |  |  |  |  |  |  |  |  |
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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
|  | x | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 |
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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 |
|  | x | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 |
|  |  |  |  |  |  |  |  |  |  |
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Points awarded: \_\_\_\_\_\_\_\_\_ out of a possible 15.

Question 8

The bit patterns below represent 32-bit floating point numbers according to the IEEE standard with a sign bit first, then an 8-bit exponent biased by 127 (emax of +127) and the remaining bits as the significand, convert the numbers to decimal. State the sign, biased exponent and significand for each part. [5 points parts a, b & c]

1. 11000001110000000000000000000000

|  |  |
| --- | --- |
|  | |
|  | |
| Sign |  |
| Biased Exponent |  |
| Significand |  |
| Answer |  |

1. 00111111011000000000000000000000

|  |  |
| --- | --- |
|  | |
|  | |
| Sign |  |
| Biased Exponent |  |
| Significand |  |
| Answer |  |

1. 00111111111100000000000000000000

|  |  |
| --- | --- |
|  | |
|  | |
| Sign |  |
| Biased Exponent |  |
| Significand |  |
| Answer |  |

Question continues over page

1. Multiple the results of part a and part b together and write the answers as a 32-bit floating point number, show working out. [10 points]

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| Sign |  |
| Exponent |  |
| Significand |  |
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Points awarded: \_\_\_\_\_\_\_\_\_ out of a possible 25.