Coláiste na Tríonóide, Baile Átha Cliath
Trinity College Dublin
Ollscoil Átha Cliath | The University of Dublin

**Faculty of Engineering, Mathematics and Science**

**School of Computer Science and Statistics**

**Senior Freshman Integrated Computer Science** **Michaelmas Term 2021**
**Senior Freshman Computer Science Joint Honours**

# Systems Programming

**10th December 2021** **Take Home Exam** **14.00 – 19.00**

**Dr David Gregg**

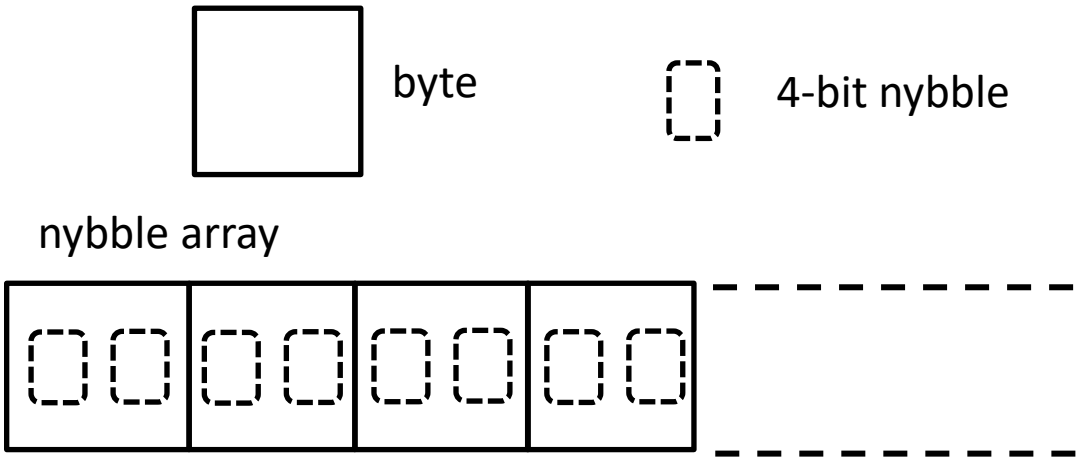
**Instructions to Candidates**:

- Answer 1 out of the 2 questions
- All questions are marked out of 100
- All program code should be commented, indented and use good programming style
- Answers to the questions should be completed by completing corresponding assignments that can be found on the CSU22014 Blackboard page.

**Materials permitted for this examination**:

## Question 1

On most computers the smallest sized piece of memory that can be accessed is a byte. However, for some applications it is useful to be able to operate on sub-byte sizes of data. For example, half a byte (4 bits) is often called a nybble. We want to pack two nybbles into each byte in memory as follows:




Write a C abstract data type (ADT) to represent a sequence of nybbles that can be indexed like an array. Each nybble value within the array should be a 4-bit unsigned integer value capable of representing a value in the range 0 to 15. Your ADT should store the nybbles internally by packing two nybbles into each byte of storage. Your ADT should support the following functions:

a) // create new array of nybbles with space for "size" nybbles and initialize the
   // values of the array to zero
   struct nybble_array * nybble_array_new(int size); [24 marks]

b) // return the nybble value at position index
   unsigned get_nybble_value(struct nybble_array * this, int index); [22 marks]

c) // set the nybble at position index to value
   void set_nybble_value(struct nybble_rray * this, int index, unsigned value);
   [22 marks]

d) // free the memory used by a nybble array
   void nybble_array_free(struct nybble_array * this); [8 marks]

e) // given an array of unsigned integers with values 0 to 15, create a

```
// new nybble array with the same values
struct nybble_array * unsigned_to_nybble_array(unsigned * array, int size);
```

[12 marks]

f) 
```
// given an array of nybbles, create a new array of unsigned integers with the same values
unsigned * nybble_array_to_unsigned(struct nybble_array * this);
```

[12 marks]

This is an online exam. Students will be given C language source files in which to write their solution, and test cases that they can use to test their code.

[Total: 100 marks]