= COMP1917 Final Exam 2012s1 =
== Afternoon ==
== Time allowed: 2.5 Hours ==
== Total number of questions: 21 ==
== Total number of marks: 100 ==

Write your answers in the text boxes in this application.
Your answers can be submitted by pressing save on this application.

You may submit your solutions as many times as you like. The last submission ONLY will be marked.

You have to check that the answers are saved successfully by looking at the line at the bottom which should say "Saved and Submitted".
If it say "Saving..." call the invigilator for assistance.

Write your name on the top of each sheet of rough working paper you use, this will not be marked.

You must hand in ALL writing paper at the end of the exam.

You may only use this application for entering your answers and the pdf viewer for the textbook. Compilers or other software tools may not be used. Calculators may not be used. The eating of toast in the exam room is prohibited. You must not attempt to communicate with any other person, or access other computers or any internet resources. If you do not follow these instructions you will get zero marks for the exam and a possible charge of academic misconduct.

Unless advised otherwise you may not use any language features or library functions not covered in class. Code which does not comply with the course style guide, or which is overly complex or unclear will be penalised.

Questions (and sub-questions) are not worth equal marks. Answer all questions.

== PART A: Multiple Choice and Short Answer Questions ==

Your working is not marked in Part A. Questions are not all of equal value. Keep your answers clear and very brief. Messy or long answers will not be marked.

=== Question 0 ===

(2 Marks)

Consider the following C definition:

```
{{{
char str[] = "Hello World?";
}}}
```

The size of the array str in characters is:

```
 .[A] 12
 .[B] 13
 .[C] 24
 .[D] 26
 .[E] None of the above
```

=== Question 1 ===

(2 Marks)

Consider the following C code:

```
{{{
char *s = "dcba";
}}}
```

What is the value of `s[4]`?

.[A] 'a'
.[B] 0
.[C] segmentation violation
.[D] 4
.[E] None of the above

=== Question 2 ===

(2 Marks)

Consider the following C code:

```
{{{
int i;
int *x = malloc(10*sizeof(int));
for(i=0; i<5; i++) {
   x[i] = i*i;
}
}}}
```

What is the value of `*(&amp;x[2]+1)`?

.[A] 0
.[B] 1
.[C] 4
.[D] 9
.[E] None of the above

=== Question 3 ===

(2 Marks)

Given the following fragment of code

```
{{{
int b = 2;
int a = 1;
int *p = NULL;
p = &a;
*p = 3;
p =&b;
*p = b;
printf("%d\n",a);
}}}
```

What will this program print out?

.[A] 1
.[B] 2
.[C] 3
.[D] 4
.[E] None of the above

=== Question 4 ===

(3 Marks)

Given the following fragment of code

```
{{{
typedef struct _complex *Complex;
typedef struct _complex {
   double real;
   double imaginary;
} complex;

Complex add (complex a, complex b){
   complex answer;
   answer.real = a.real + b.real;
   answer.imaginary = a.imaginary + b.imaginary;
   return &answer;
}

complex a = {1.0,2.0};
complex b = {3.0,4.0};
Complex c;
Complex d;
c = add(b,a);
d = add(*c,a);
}}}
```

What will the value of `d->real` after executing this code?

.[A] 1.0
.[B] 3.0
.[C] 5.0
.[D] It is undefined
.[E] None of the above

=== Question 5 ===

(3 Marks)

Consider the following code fragment:

```
{{{
   int x[] = {0, 1, 2, 3};
   int temp;
   int i;
   int j = (sizeof (x)/sizeof (int)) - 1;
   for (i = 0; i < j; i++) {
      temp = x[i];
      x[i] = x[j];
      x[j] = 2*temp;
      j--;
   }
}}}
```

After this code is executed, array x contains the values:
.[A] {3, 2, 2, 0}
.[B] {0, 1, 2, 3}
.[C] {3, 2, 1, 0}
.[D] It is undefined
.[E] None of the above

=== Question 6 ===

(3 Marks)

Consider the following definitions for a `List` (note that we are keeping track of the last element of the list).

```
{{{
typedef struct _list *List;
typedef struct _node *nodePointer;

typedef struct _node {
  item value;
  nodePointer next;
} node;

typedef struct _list {
  nodePointer first;
  nodePointer last;
} list;
}}}
```

Here is a fragment of code that I wrote to add a value `v` to the end of the list in the case where the list has at least one element.

```
{{{
addToEndOfNonemptyList(List l, int v){
   nodePointer temp;
   assert(l->last != NULL);

   temp->value = v;              //Line 1
   temp = malloc(sizeof(node)); //Line 2
   l->last = temp;              //Line 3
   l->last->next = temp;        //Line 4
   temp->next = NULL;           //Line 5
}
}}}
```

Of course, as you all know I make lots of mistakes in my programs and the five numbered lines in the code above might have to be rearranged to make my function work properly. What is an ordering of the five numbered lines of code that makes the function correct?

 .[A] 1, 2, 3, 4, 5
 .[B] 2, 1, 3, 4, 5
 .[C] 2, 5, 1, 4, 3
 .[D] 2, 1, 5, 3, 4
 .[E] None of the above

=== Question 7 ===

(3 Marks)

Which of the following code fragments calculates the product of the first N values in a an array declared like this:

```
{{{
int a[N];
int product;
int i;
}}}
```

 .[A]

```
{{{
```

```
product = 1;
for (i = 0; i <= N; i++) {
   product *= a[i];
}
}}}
```

 .[B]

```
{{{
product = 0;
for (i = 0; i <= N; i++) {
   product *= a[i];
}
}}}
```

 .[C]

```
{{{
product = 0;
for (i = 1; i <= N-1; i++) {
   product *= a[i];
}
}}}
```

 .[D]

```
{{{
product = 1;
for (i = 1; i <= N-1; i++) {
   product *= a[i];
}
}}}
```

 .[E] None of the above

=== Question 8 ===

(3 Marks)

What is the output of the following 4003 program? (I've added comments giving the address and meaning of each instruction.)

```
{{{
1 //0 R0++
1 //1 R0++
3 //2 R1++
3 //3 R1++
2 //4 R0--
3 //5 R1++
3 //6 R1++
8 4 //7 if R0 != 0 goto 4
5 //9 R0<->R1
7 //10 Print R0
0 //11 Halt
}}}
```

 .[A] 0
 .[B] 2
 .[C] 4
 .[D] 6
 .[E] None of the above

=== Question 9 ===

(3 Marks)

Given the following fragment of code

```
{{{
```

```
#define N 6
int i;
char a[N];
for (i = 0; i < N-1; i++){
    a[i] = 'A' + i;
}
a[2] = '\0';
printf("%c\n",a[1+strlen(a)]);
}}}
```

What will this program print out?

.[A] A
.[B] B
.[C] C
.[D] D
.[E] None of the above

=== Question 10 ===

(3 Marks)

Consider the following code fragment:

```
{{{
int g(int *x, int y, int z){
   z = *x;
   *x = y;
   y = z*z;
   return z+y;
}

int f(int *x, int y, int *z) {
   return g(&y, *z, *x);
}

int x = 1;
int y = 2;
int z = 3;
x = f(&z, x, &y);
}}}
```

After this code is executed, x has the value:
.[A] 1
.[B] 2
.[C] 3
.[D] 4
.[E] None of the above

=== Question 11 ===

(3 Marks)

Consider the following code:

```
{{{
// insert a value into the first position in an array,
//moving everthing else up to make room
void insert(int a[], int *size, int value) {
   int i;
   for(i=0; i < *size; i++){
      a[i+1] = a[i];
   }
   a[0] = value;
   *size++;
}
}}}
```

What is the main point you would raise in reviewing the above code?

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=== Question 12 ===

(4 Marks)

Given the following code:

```
{{{
char str[] = "a dog!";
int len = strlen(str);
str[len] = '\n';
str[len+1] = '\0';
printf("%s\n",str);
}}}
```

What is the main point you would raise in reviewing the above code?

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What result would you expect from compiling/running the program and why?
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== PART B: Programming I ==

Make your answers as clear and easy to understand as possible. Provide brief comments in your code where necessary. Confusing or illegible solutions will lose marks.

If you do not wish your answer for a question to be marked, write 1 SYMPATHY MARK PLEASE in the space for the answer. If you do this you will be awarded one sympathy mark and your answer for that question will not be marked.

=== Question 13 ===

(6 Marks)

Write a function with prototype

```
{{{
int drawBox(int n);
}}}
```

that draws a hollow box n characters wide and high using '*' and ' ' characters.
For example `drawBox(4)` should produce

```
{{{
```

```
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*  *
*  *
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}}}
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=== Question 14 ===

(5 Marks)

C has a library function called isalnum that returns 1 if a character is a letter or a number. Without using isalnum or any other functions from the ctype.h library, write a function that tests if a character is a letter or a number. You should use the following prototype.

```
{{{
int isAlNum (char c);
}}}
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=== Question 15 ===

(7 Marks)

Write out the contents of a small file twos.c which complies with the course style guide and, when compiled and executed on a lab machine with the commands:

```
{{{
gcc -Wall -Werror -o twos twos.c
./twos
}}}
```

reads in a number N and prints out the number of times it can be halved before obtaining an odd number.

For example given 5 it would print 0 (as 5 is itself odd), and given 12 it would print 2 (as half of twelve is six, and half of six is three, which is odd, hence 12 can be halved twice.)

```
{{{
$ ./twos
5
0
$ ./twos
6
1
$ ./twos
12
2
$ ./twos
64
6
}}}
```

You may assume that N is a positive integer between 1 and 1,000,000.

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== PART C: Programming II ==

Make your answers as clear and easy to understand as possible. Provide brief comments in your code where necessary. Confusing or illegible solutions will lose marks.

If you do not wish your answer for a question to be marked, write 1 SYMPATHY MARK PLEASE in the space for the answer. If you do this you will be awarded one sympathy mark and your answer for that question will not be marked.

=== Question 16 ===

(8 Marks)

Consider the following definitions for a `List`

```
{{{
typedef struct _list *List;
typedef struct _node *nodePointer;

typedef struct _node {
  item value;
  nodePointer next;
} node;

typedef struct _list {
  nodePointer first;
} list;
}}}
```

Write a function which implements the prototype

```
{{{
void replaceOne (List l, int old, int new);
}}}
```

which replaces the first occurence of the value `old` in the list with `new`. For example, if `l` has the values 1,2,4,2 in that order after
`replaceOne (l, 2, 7);`
`l` would have the values 1,7,4,2

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=== Question 17 ===

(8 Marks)

Write a 8004 program to calculate the length of a C style string starting in cell 200 and print out the length (the length should be the only thing printed).

For example if cell 200 contained 65 and cell 201 contained 69 and cell 202 contained 0 your program should print 2.

Include C-style // comments in your machine code. Make your answer clear with lot of comments and a line by line explanation of what you are doing.

You can also include C-style `#define` statements. Assume that I have already written

```
{{{
#define X 250
}}}
```

so that if you write `X` in your machine code it will be replaced by 250.

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=== Question 18 ===

(14 Marks)

You are to design and partially implement an ADT to represent a board for the game of Chess Dominoes. Chess Dominoes is played on a chessboard using dominoes. Each Domino covers two squares on the chessboard. Players take turns each placing a domino on two unoccupied squares on the chessboard on there turn. The first player uses white dominoes while the second player uses black ones. This is what the board might look like after each player has had three turns.

```
{{{
 01234567
0B.......
1BWW...WW
2BB.W....
3...W....
4........
5...BB...
6........
7........
}}}
```

To win the game a player must make a path with their dominoes from one side of the board to the other. For example, Black has won this game:

```
{{{
 01234567
0B.......
1BWW...WW
2BB.W....
3.B.W....
4.BBB...W
5.WWBBBBW
6..WWWWBW
7......BW
}}}
```

We want an ADT Board that can be used by a computer program to referee a game between two humans (or AIs).

You will write the header file Board.h, and a file Board.c which implements some of the ADT.

Write the interface file Board.h. In it include the typedef for the abstract type "Board", definitions for any constants, and the prototypes and brief descriptions of the interface functions.

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Implement a function in file Board.c with prototype

```
{{{
```

int canMove(Board b, int row, int col, int orientation);
}}}

which returns whether it is possible to place a domino on the specified square and in the specified orientation (HORIZONTAL or VERTICAL). It should return 1 if it is possible, otherwise 0.

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Implement a function in file Board.c with prototype
{{{
int move(Board b, int row, int col, int orientation);
}}}

which places a domino the current player on the specified Square and in the specified orientation. It can assume that the move is legal.

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Implement a function in file Board.c with prototype
{{{
int display(Board b);
}}}
that prints out the current board as in the examples above

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== PART D: Challenge Part ==

Partial solutions for these questions (i.e. attempts worth less than 50%) will score no marks in this part.

Your solution must be clear, elegant and easy to understand. In this part confusing or difficult to understand solutions will score no marks.

If you do not wish your answer for a question to be marked, write 1 SYMPATHY MARK PLEASE in the space for the answer. If you do this you will be awarded one sympathy mark and your answer for that question will not be marked.

=== Question 19 ===

(8 Marks)

Consider the following definitions for a `List`

```
{{{
typedef struct _list *List;
typedef struct _node *nodePointer;

typedef struct _node {
  item value;
  nodePointer next;
} node;

typedef struct _list {
  nodePointer first;
} list;
}}}
```

Write a function which implements the prototype

```
{{{
int loopSize (List l);
}}}
```

which returns the numver of nodes in the loop if the list contains a loop, or 0 if there is no loop. For example, if the list has three nodes with values 1, 2 and 3 and instead of the next pointer for node 3 being NULL instead it points to node 2, then the loopSize is 2.

```
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```

=== Question 20 ===

(8 Marks)

Implement a function in file Board.c for Chess Dominoes with prototype

```
{{{
int gameOver(Board b);
}}}
```

that determines if the game is over. That is, it returns 1 if either Black or White has a path from one side of the board to the other.

```
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```