NATIONAL UNIVERSITY OF SINGAPORE

SCHOOL OF COMPUTING

MID-SEMESTER TEST
AY2015/16 Semester 2

CS1010 PROGRAMMING METHODOLOGY

9 March 2016   Time Allowed: 1 hour 30 minutes

INSTRUCTIONS

1. This question paper contains ELEVEN (11) questions and comprises SIX (6) printed pages, including this page.

2. An ANSWER SHEET is provided for you to write the answers. It comprises TWO (2) printed pages.

3. Answer ALL questions within the space provided on the Answer Sheet.

4. Maximum score is 30 marks.

5. This is an OPEN BOOK test.

6. Electronic devices, including but not limited to laptop, electronic dictionary and calculator, are NOT allowed.

7. Switch off/silence your mobile phone and keep it out of view.

8. Write your MATRICULATION NUMBER on the Answer Sheet using A PEN.

9. Write your answers legibly with a pen or pencil.

10. Submit only the Answer Sheet at the end of the test. You may keep the question paper.

——— END OF INSTRUCTIONS ———
**SECTION A: Multiple Choice Questions (5 Marks)**

Each question has only one correct answer. Write your answers in the boxes provided on the Answer Sheet. 1 mark for each correct answer and no penalty for wrong answer.

1. Which of the following variable names are valid?
   
   i. `INT`
   
   ii. `#count`
   
   iii. `true`
   
   iv. `position-x`
   
   v. `9999`
   
   vi. `1001night`
   
   A. (i), (ii) and (iv)
   
   B. (i), (iii) and (v)
   
   C. (ii), (iii), and (v)
   
   D. (iii), (iv) and (v)
   
   E. None of the above options is correct.

2. Which of the following statements is correct?
   
   A. A return statement can be used to return the values of more than one variable.
   
   B. After a return statement is executed inside a loop, the loop will proceed to its next iteration (if any).
   
   C. A return statement may only appear at the end of a function.
   
   D. A function may contain any number of return statements.
   
   E. None of the above options is correct.

3. What are the final values of `a`, `b` and `c`?

   ```
   int a = 0, b = 0, c = -1;
   if ( b = a || b == ++c )
      a+=3;
   ```
   
   A. 0 0 0
   
   B. 0 1 0
   
   C. 3 0 0
   
   D. 3 1 0
   
   E. None of the above options is correct
4. What does the following function return given an integer \( n \) where \( n \geq 2 \)?

```c
int func(int n){
    int i = 2;
    while (i < n){
        if (!(n%i)) return 0;
        else return 1;
        i++;  
    }
    return 1;
}
```

A. It always returns 0.
B. It always returns 1.
C. It returns 1 if \( n \) is a prime number, or 0 otherwise.
D. It returns 1 if \( n \) is a composite number, or 0 otherwise.
E. None of the above options is correct.

5. Which of the following are equivalent for initializing the array \( \text{arr} \)?

i. \( \text{int arr}[5] = \{4, , 2, , 0\} \);  
ii. \( \text{int arr}[5] = \{4, 0, 2\} \);  
iii. \( \text{int arr}[5], i; \)
    
    for (i = 4; i >= 0; i--)
    
    if ( (i+1)%2)
    
    \( \text{arr}[i] = 4-i; \)

iv. \( \text{int arr}[5] = \{4, 3, 2, 1, 0\}, i=0, \text{temp}; \)

    do {
    
    if (arr[i]%2)
    
    \( \text{arr}[i] = 0; \)
    
    i++;
    
    } while (i <= 4);

A. (i) and (ii)
B. (ii) and (iii)
C. (ii) and (iv)
D. (iii) and (iv)
E. None of the above options is correct.
SECTION B: Structured Questions (13 Marks)

Write your answers in the boxes provided in the Answer Sheet.

6. Assuming the statements in the loop body does not affect the answer, how many times does each of the following loops execute its loop body? [3 marks]

(a) int i = 0; while (++i < 5){ ... }
(b) int i = 10; while (i % 2) { ... }
(c) int i; for (i = 1; i < 10; i+2){ ... }

7. What is the output of the following code fragment? [2 marks]

```c
int a = 5, b = 3, temp, *ptr1, *ptr2, *ptr3;
ptr1 = &temp;
ptr2 = &a;
ptr3 = &b;
ptr1 = ptr2;
ptr2 = ptr3;
ptr3 = ptr1;
temp = *ptr2;
*ptr2 = *ptr1;
*ptr1 = temp;
printf("%d %d\n", a, b);
```

8. What is the output of the following code fragment? [3 marks]

```c
int arr[5] = {1, 2, 3, 4, 5}, size = 5, i, j, temp;
for (i = 0; i < size/2; i++){
    temp = arr[i];
    for (j = i; j < size-2; j+=2)
        arr[j] = arr[j+2];
    arr[j] = temp;
}
for (i = 0; i < size; i++)
    printf("%d ", arr[i]);
```
9. Complete the following function such that given two positive integers length and width, it prints a sequence of lines which look as if a row of length asterisks flies past a window of width characters wide from right to left. [5 marks]

```c
void fly(int length, int width) {
    int i, j;

    for (i = 1; i < length+width; i++)
        for (j = 0; j++)
            printf("\n");

    for (i = 0; i < length; i++)
        for (j = 0; j++)
            printf("*");

    for (i = 0; i < width; i++)
        for (j = 0; j++)
            printf("\n");

    printf("\n");
}
```

SECTION C: Short Programming Question (12 Marks)
Write your answer in the space provided on the Answer Sheet.

10. Write a function int isgeometric(int arr[], int n). If the given array arr of n (n>=2) elements contains a geometric sequence {1, a, a^2, a^3, ..., a^(n-1)} where a is a non-zero integer, this function returns 1; otherwise it returns 0. For example, this function returns 1 for {1, 2, 4, 8, 16} but 0 for {1, 2, 3, 4, 5} since the former is a geometric sequence while the latter is not. [4 marks]
11. The **Eratosthene's Method** is a method for finding all prime numbers no greater than a given a positive integer \( n \) (where \( n \geq 2 \)) using a list of consecutive integers from 2 through \( n \): \{2, 3, 4, ..., \( n \}\}. A brief description of this method is as follows:

| Initially, let \( p \) equal 2, the first prime number. |
| Starting from \( p \), enumerate its multiples by counting to \( n \) in increments of \( p \), and mark them in the list (these will be \( 2p, 3p, 4p, ... \); the \( p \) itself should not be marked). |
| Find the first number greater than \( p \) in the list that is not marked. If there was no such number, stop. Otherwise, let \( p \) now equal this new number (which is the next prime), and repeat the enumerating and marking process. |

For example, let say \( n \) is 10. The list of consecutive integers is then \{2, 3, 4, ..., 8, 9, 10\}. The enumerating and marking process for this list is follows:

| Round 1: Start with \( p = 2 \), enumerate and mark 4, 6, 8 and 10. |
| Round 2: Move on to 3, enumerate and mark 6 and 9. |
| Round 3: Move on to 5 (skipping 4 since it is marked), enumerate and mark 10. |
| Round 4: Move on to 7 (skipping 6). There is no number to be enumerated and marked. |
| There is no more number greater than \( p \) which has not been marked so the process ends. |

You may assume that \( n \) is no bigger than 100000.

(a) Write an algorithm in plain English or in pseudo-code for 1) generating a list containing (only) all the prime numbers no greater than \( n \) based on the Eratosthene's Method, and 2) computing the total number of prime numbers in the list generated.

For example, given \( n = 10 \), the first 4 numbers in the generated list should be 2, 3, 5 and 7. (No other positive integers should appear in list.) The total number of prime numbers in the list generated should be 4.

Note: The steps in your algorithm must be very specific and detailed (e.g., it must be clear how variables are used and updated). No marks will be awarded if your algorithm is merely a paraphrase of the description given above. [4 marks]

(b) Translate your algorithm in (a) into a C function with the following header:

```c
int findPrimes(int n, int primes[])
```

This function takes in an integer \( n \), generates the list of prime numbers and stores it into the `int` array `primes`. It also returns the number of prime numbers in the list.

For example, given \( n = 10 \), the first 4 numbers in `primes` should be 2, 3, 5 and 7. (No other positive integers should appear in `primes`. ) The function should also return 4 as the result. [4 marks]