

NATIONAL UNIVERSITY OF SINGAPORE  
CS1101S — PROGRAMMING METHODOLOGY

(AY2018/2019 SEMESTER 1)

READING ASSESSMENT 2, REDACTED EDITION OF 2020/21

Time Allowed: **45 Minutes**

**1**

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**ANSWERS**

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**INSTRUCTIONS**

1. This question paper comprises **NINE (9)** printed pages, including this page.
2. You are also provided with **one OCR Form** to write your answers.
3. Clearly **write** and **shade** your **STUDENT NUMBER** on your **OCR Form** using a **2B PENCIL**.
4. There are **17** multiple-choice questions. Each question has one correct answer. **1 mark** is awarded for each correct answer and there is no penalty for a wrong answer.
5. The full score is **17 marks**.
6. Answer **ALL** questions.
7. Use only a **2B PENCIL** to **shade** your answers on your **OCR Form**.
8. This is a **CLOSED BOOK** assessment, but you are allowed to bring in one A4 sheet of notes (handwritten or printed on both sides).
9. **Submit only the OCR Form.**

- (1) What is the single-digit **number** at the **top-right corner** on the **front page** of this question paper? (**Important:** Please make sure your answer is correct because it determines how we mark your answers to all the subsequent questions.)

A. 1 **(answer)**  
 B. 2  
 C. 3  
 D. 4  
 E. 5

Consider the following Source program for the next 3 questions:

**Program A:**

```
x => x + 1;

function funA(n) {
    return n <= 1 ? n : funA(n - 1) + funA(n - 2);
}
const aa = funA(4);
```

- (2) How many bindings appear in the program environment frame?
- A. 0  
 B. 1  
 C. 2 **(answer)**  
 D. 3  
 E. More than 3
- (3) How many environment frames get created during the evaluation of Program A? (Do not count the global environment frame.)
- A. 0  
 B. 1  
 C. 4  
 D. 10 **(answer)**  
 E. None of the above
- (4) Of the environment frames that get created during the evaluation of Program A, how many extend the program environment *directly*?
- A. 0  
 B. 1  
 C. 4  
 D. 9 **(answer)**  
 E. None of the above

- (5) How many environment frames get created during the evaluation of the following program? (Do not count the global environment frame.)

```
function funB(n) {  
  if (n <= 1) {  
    return n;  
  } else {  
    let xx = funB(n - 1);  
    let yy = funB(n - 2);  
    return xx + yy;  
  }  
}  
funB(4);
```

- A. 14 **(answer)**
- B. 9
- C. 4
- D. 1
- E. None of the above

- (6) What is the result of evaluating the following program?

```
let xx = 0;  
let yy = 0;  
  
function funC(n) {  
  if (n <= 1) {  
    return n;  
  } else {  
    xx = funC(n - 1);  
    yy = funC(n - 2);  
    return xx + yy;  
  }  
}  
funC(12);
```

- A. 1
- B. 6 **(answer)**
- C. 21
- D. 144
- E. None of the above

Consider the following Source program for the next 4 questions:

**Program D:**

```
function ff(xx) {
  function gg(yy) {
    return xx * yy;
  }
  return gg;
}
const aa = ff(1)(6);
const bb = ff(2)(5);
ff(aa)(bb);
```

- (7) How many function objects get created during the evaluation of Program D?
- A. 6
  - B. 4 **(answer)**
  - C. 3
  - D. 2
  - E. 1
- (8) How many environment frames get created during the evaluation of Program D? (Do not count the global environment frame.)
- A. 1
  - B. 3
  - C. 7
  - D. 9
  - E. None of the above **(answer)**
- (9) Of the environment frames that get created during the evaluation of Program D, how many extend the program environment *directly*?
- A. 1
  - B. 3 **(answer)**
  - C. 6
  - D. 9
  - E. None of the above
- (10) During the evaluation of Program D, some of the environment frames contain the name `xx`. Which other name do these frames also contain?
- A. `gg`
  - B. `ff`
  - C. `yy`
  - D. `aa`
  - E. None of the above **(answer)**

Consider the following Source program for the next 4 questions:

**Program E:**

```
function dest_map(fun, xs) {
  if (! is_null(xs)) {
    const h = head(xs);
    set_head(xs, fun(h));
    dest_map(fun, tail(xs));
  } else { }
}
const L = list(1, 2, 3);
dest_map(x => y => x + y, L);
```

- (11) How many function objects get created during the evaluation of Program E?
- A. 1
  - B. 2
  - C. 4
  - D. 5 **(answer)**
  - E. None of the above
- (12) How many environment frames get created during the evaluation of Program E? (Do not count the global environment frame. We assume that the application of a primitive function does not create any frame. See Appendix for a list of primitive functions.)
- A. 7
  - B. 3
  - C. 11 **(answer)**
  - D. 4
  - E. None of the above
- (13) Of the environment frames that get created during the evaluation of Program E, how many extend the program environment *directly*?
- A. 7 **(answer)**
  - B. 3
  - C. 2
  - D. 4
  - E. None of the above

(14) Which of the following statements, when added to the end of Program E, will change the value of L back to `list(1, 2, 3)`?

- A. `dest_map(x => y => x - y, L);`
- B. `dest_map(x => x - y, L);`
- C. `dest_map(x => x(0), L);` **(answer)**
- D. `dest_map(x => y => x(-y), L);`
- E. None of the above

Consider the following Source program for the next 3 questions:

**Program F:**

```
function mystery(A) {
  const len = array_length(A);
  let i = len - 1;
  while (i >= 1) {
    let j = 1;
    while (j <= i) {
      const temp = A[j - 1];
      if (A[j - 1] > A[j]) {
        A[j - 1] = A[j];
        A[j] = temp;
      } else { }
      j = j + 1;
    }
    i = i - 1;
  }
}
const aa = [7, 3, 10, 4, 9, 8, 1, 5, 2, 6];
mystery(aa);
aa;
```

(15) How many environment frames get created during the evaluation of Program F? (Do not count the global environment frame. We assume that the application of a primitive function does not create any frame. See Appendix for a list of primitive functions.)

- A. 91
- B. 56
- C. 46
- D. 19
- E. None of the above **(answer; the correct number is 57)**

(16) Of the environment frames that get created during the evaluation of Program F, how many are created for the *inner while*-loop in the function `mystery`?

- A. 0
- B. 9
- C. 45 (answer)
- D. 81
- E. None of the above

(17) What is the value of `aa` at the end of the evaluation of Program F?

- A. [1, 3, 5, 7, 9, 10, 2, 4, 6, 8]
- B. [3, 7, 4, 9, 8, 1, 5, 2, 6, 10]
- C. [7, 7, 7, 7, 7, 7, 7, 7, 7, 7]
- D. [10, 9, 8, 7, 6, 5, 4, 3, 2, 1]
- E. [1, 2, 3, 4, 5, 6, 7, 8, 9, 10] (answer)

———— END OF QUESTIONS ————

## Appendix

### Primitive Functions

The following are some of the primitive functions in Source §3:

- `display(a)`
- `pair(x, y)`
- `is_pair(x)`
- `head(x)`
- `tail(x)`
- `is_null(xs)`
- `list(x1, x2, ..., xn)`
- `set_head(p, x)`
- `set_tail(p, x)`
- `array_length(x)`

### Pre-declared Functions

Some of the pre-declared functions in Source §3 are declared as follows:

```
function length(xs) {
  return is_null(xs)
    ? 0
    : 1 + length(tail(xs));
}

function map(f, xs) {
  return is_null(xs)
    ? xs
    : pair(f(head(xs)), map(f, tail(xs)));
}

function filter(pred, xs) {
  return is_null(xs)
    ? xs
    : pred(head(xs))
      ? pair(head(xs), filter(pred, tail(xs)))
      : filter(pred, tail(xs));
}

function accumulate(op, initial, xs) {
  return is_null(xs)
    ? initial
    : op(head(xs), accumulate(op, initial, tail(xs)));
}
```



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