Computer Programming - Final Mock

考試時間 Test time 15:50 pm to 18:10 pm; 2.5 hours. 以投影時鐘為準 Using the projected clock as official time. 在答案卷上作答 Answer on the answer sheet. 每題一分 One point per problem. 全對才給分 No partial credit. 不倒扣 No penalty for wrong answers. 禁止外部資源（比照學測、分科） No external resources, like TOEFL.

```
class Rabbit {
    int age;
    string name;
public:
    // constructors here
    // get_age() here
    // rename() here
}
```

[1] By default, class members are (A) protected (B) private (C) public (D) friend

[2] By default, struct members are (E) protected (F) private (G) public (H) friend

[3] Define the default constructor that sets the age to `0` and the name to `unnamed rabbit`.

[4] Define a constructor that sets the age to `0` and the name to the argument.

[5] Define the getter function of `age`.

[6] Define the setter function `rename` that takes one string as argument; if the string contains only `a`–`z` (all lowercase), then rename. Otherwise return false.

```
class Dog { public:
    int age;
    ...
}
class Chiwawa : public Dog { public:
    int dB;
    ...
}
```

[7] If `p1` is a pointer to a dog, how does `p1->age` work? (I) The compiler replaces it with `p1.(*age)`. (J) The runtime searches for `age` in the dictionary of of the dog. (K) The compiler replaces it with `*(p1 + shift)` for some number `shift`.

[8] If the type of `p2` is pointer-to-dog, but it points to a chiwawa, how does `p2->age` work? (L) The runtime cast `*p2` to a dog first and the problem reduces to the previous question. (M) The runtime searches for `age` in the dictionary of of the chiwawa. (N) The compiler replaces it with `*(p2 + shift)` for the same `shift` as the last question. (O) The compiler replaces it with `*(p2 + shift)` for some different `shift`. (P) This does not work.

[9] If the type of `p3` is a pointer-to-chiwawa, but it points to a dog, how does `p3->age` work? (Q) This is not possible. (R) The runtime cast `*p3` to chiwawa using the default constructor. (S) The compiler replaces it with `*(p3 + shift)` for the same number as the last question. (T) The compiler replaces it with `*(p3 + shift)` for some different number `shift`.

[10] If the type of `p4` is a pointer-to-dog, but it points to a chiwawa, how does `p4->dB` work? (U) The runtime cast `p4` to pointer-to-chiwawa and perform `->dB` (V) The runtime searches for `dB` in the dictionary of of the chiwawa. (W) The compiler replaces it with `*(p4 + shift)` for some different number `shift`. (X) This does not work.

[11] If you answer to the previous question implies that the compiler knows that p4 points to a chiwawa, why does it know? If your answer implies that the compiler does not know, how to fix the code so that it knows?

[12] Which of the following are the benefit of using array of structures: `Dog HuangBaBa[100]`? (Y) Better cache locality when increasing all dogs ages. (Z) Encapsulation and readable code: easy to pass `Dog*` to functions. (A) Easier to sort dogs by age or name as we only modify one array. (B) Uses less memory because this avoids padding between two arrays.

[13] Which of the following is the benefit of using structures of arrays: `int ages[100]; string names[100];`? (C) Enables SIMD/vectorization for single-field operations. (D) Uses less memory because this avoids padding between members. (E) Easier to sort dogs by age or name as we only modify one array. (F) Encapsulation and readable code: it suffices to pass index `i` to functions.

```
int y = 2;
@@@ f = [=y](auto x) { return x * y; }
### g = [&y](auto x) { return x + y; }
y = 1;
```

[14] What should @@@ be?

[15] What should ### be?

[16] What is `f(g(2))`?

[17] Using composition of the form `f(g(...(g(f(0)))...))` to produce `101`.

```
auto pi = make_pair(3.14, "pi");
auto e = make_pair(2.71, "e");
auto [a, b] = pi;
auto [c, d] = e;
```

[18] Another way to obtain `a` is `auto a = pi.???;`

[19] Another way to obtain `b` is `auto b = pi.???;`

[20] The function template `make_pair` is defined in the standard library. But how is it defined? You may assume that the structure template `pair` is already defined. You also dont need to worry about `const` or `&` (pass by reference thing).

[21] How to use `decltype` to make `DS` the type of `pi`?

[22] Overload the `+` operator for `DS` so that `pi + e` produces `make_pair(5.85, "pi + e")`.

```
template<typename T>
T sum(T one) { return one; }
template<typename T, typename ... TT>
T sum(T first, TT ... rest)
{ return first + sum(rest); }
```

[23] To the right is a usage of variadic template. Use the similar style to define `apply` so that `apply(x, f, g, h)` produces `h(g(f(x)))`.

[24] Let $t_0, t_1, t_2, \ldots$ be the Thur–Morse sequence defined as:

$$t_0 = 0,\ t_{2n} = t_n,\ t_{2n+1} = 1 - t_n.$$

Let `Car` be a class. Overload the `+` operator for `queue<Car>` so that the jth element of the `q1 + q2` is from `q1` if $t_j = 0$ and from `q2` if $t_j = 1$. Note that cars from the same queue should remain in the same order.

```
sort(VVI.begin(), VVI.end(),
[](auto a, auto b) {
    ???
});
```

[25] For something like `vector<vector<int>> VVI = { {1,2,3}, {4,5}, {6} };` how to sort it so that shorter vectors come first, and for vectors of the same length, lower sum comes first, and for vectors of the same length and sum, using dictionary order?

[26] Overload the `()` operator for `vector<T>` so that `v(3)` returns `v[3]` and `v(-5)` returns `v[v.size() - 5]`.

[27] Overload the `[]` operator for `vector<T>` so that `v[vector<int>2, 4, 8]` returns `vector<T>v[2], v[4], v[8]`.

[28] An RSA public key is `p * q = 91; e = 5`, what is the private key `d`?

```
array<bool, 127> decode(array<bool, 127> y) {
    ???
}
```

[29] A Hamming codeword is an `array<bool, 127> x;` such that $xH = 0$, where H is the matrix where the jth row is the binary representation of `j`; so the first row is `0000001` and the last row is `1111111`. Given another `array<bool, 127> y`, find the codeword `x` that differs from `y` by at most one bit.

```
A = [1, 2, 3]
B = "w x y z"
for a, b in zip(A, B):
    print(a, b)
```

[30] What is the first line of the output?

[31] What is the second line of the output?

[32] What is the fourth line of the output? (If there is no fourth line, write NONE).

[33] What is `list(map(lambda x: B[x], A))`?

[34] What is `reduce(lambda x, y: max(x, y), B, B[0])`?

[35] What is `filter(lambda x: x & 1, B)`?

[36] In the video game *The Farmer Was Replaced*, how to fertilize the entire field exactly once?

```
\def\rota#1#2#3{#2#3#1}
\def\rotb#1#2#3{#3#1#2}
\def\refl#1#2#3{#3#2#1}
```

[37] What is `\rota 123456789`?

[38] What is `\rotb\rota 123456789`?

[39] What is `\expandafter\refl\refl 123456789`?

[40] What is `\expandafter\expandafter\expandafter\refl\refl 123456789`?

```
\def\two#1{tour}
\def\to{\two\two}
\edef\too{\two\two}
\edef\tool{\noexpand\two\noexpand\two}
\edef\toll{\noexpand\two\to}
\edef\toll{\toll}
\def\two#1{tall}
\to \\ \too \\ \tool \\ \toll
```

[41] What is the first line of the output?

[42] What is the second line of the output?

[43] What is the third line of the output?

[44] What is the fourth line of the output?

[45] Which Ubuntu version is used in autograder?

[46] Which g++ version is used in autograder?

```
let add = |a: i32, b: i32| -> i32 { a * b };
let x = 5;
let y = 7;
let result = add(x, y);
println!("The sum is: {}", result);
```

[47] What is the output?

[48] What is `i32`?

[49] What is this language? (G) C (H) C++ (I) Rust (J) python (K) Haskell

[50] When did this language reach 1.0? (L) 1975 (M) 1995 (N) 2015 (O) 2025

[51] Regarding string literals, what is true? (P) Its the only way to define strings in C++. (Q) They are not stored in the executable file. (R) They can only contain alphabetic characters. (S) They are concatenated even without a plus sign.

[52] Why C++ libraries separate header files and implementation files and only the header files are included? Select two that apply. (T) The implementation is already compiled. (U) It slows down compilation if reading both. (V) To prevent errors when compiling implementation files. (W) It is the users job to implement the functions declared in headers.

[53] C++ is invented in (X) 1983 (Y) 1993 (Z) 2003 (A) 2013

```
int main (int argc, char *argv[]) {
    return 0;
}
```

[54] Which are correct about `main`? (B) A cpp file do not have to have a `main` function. (C) For `g++-14`, `argv` may contain things like `-o` and `-Wall`. (D) It is required to return a nonzero value when something goes wrong. (E) It is required to return zero when the program finishes successfully.

```
g++-14 -Wall option_pricing -o op
./op <<< "100 0.05 0.2 1 100"
```

[55] Select the correct option. (F) `-o` specifies the optimization level. (G) `option_pricing` enables on the pricing option. (H) `g++-14` refers to the compiler version announced in 2014. (I) `-Wall` turns on every warning provided by the compiler.

[56] Which command line create a new folder? (J) `ls` (K) `cat` (L) `touch` (M) `mkdir`

[57] Which command is used in the jupyter notebook to output the cell content to a cpp file? (N) `ls` (O) `cat` (P) `touch` (Q) `mkdir`

[58] `T` is a type and `T A[100];` is an array. What is `&A[11] - &A[10]`? (R) 1 (S) the size of `T` in bits (T) the size of `T` in bytes (U) compiler error, as `(&A)` is not an array and `(&A)[11]` is meaningless

[59] The binary representation of `int16_t a = -10101` is?

```
00111111100000000000000000000000 = 1
01000000000000000000000000000000 = 2
01000000010000000000000000000000 = 3
01000000100000000000000000000000 = 4
01000000101000000000000000000000 = 5
01000000110000000000000000000000 = 6
01000000111000000000000000000000 = 7
01000001000000000000000000000000 = 8
01000001000100000000000000000000 = 9
01000001001000000000000000000000 = 10
```

[60] What is the binary representation of 255?

[61] What is the binary representation of -0.375?

[62] What is the binary representation of 2^{100}?

[63] What is the binary representation of $2^{100}+1$?

[64] What standard is that? (V) IEEE 754 (W) IEEE 7382 (X) IEEE 1111 (Y) IEEE 1.414

[65] What is the `sizeof()` of this data type (Z) 4 (A) at least 4 (B) 32 (C) at least 32

[66] The largest number it can represent is $3.4 \times 10^{\text{what}}$?

[67] Knowing that $\log_2(10) = 3.322$, what is the best way to define `PI` in this data type? (D) `this_type PI = 3.14159;` (E) `this_type PI = 3.1415926;` (F) `this_type PI = 3.1415926535;` (G) `this_type PI = 3.141592653589;`

[68] Which are testing if a positive integer `n` is a multiple of 8? (H) `n % 8 == 0` (I) `n & 7 == 0` (J) `n & (n - 1) >= 8` (K) `n / 8 == (n + 7) / 8`

```
bool isSquare (int n) {
    // your code here
    // your code here
    return false;
}
```

[69] Finish this function that checks whether `n` is a perfect square. You can assume that `n` is between `0` and `1000`.

[70] What is `'^'^'^'`?

```
float f = 1;
float dfdt = 0;
float dt = 1e-3;
for (float t = 0; t < 10; t += dt) {
    float ddfddt = f;
    dfdt += ddfddt * dt;
    f += dfdt * dt;
}
```

[71] Some numerical ODE code is presented to the right. What is the equation being solved? (L) $f' = f$ (M) $f'' = f$ (N) $f' = -f$ (O) $f'' = -f$

[72] Select the implied initial conditions. (P) $f(0) = 0$ (Q) $f(0) = 1$ (R) $f'(0) = 0$ (S) $f'(0) = 1$

[73] Select all that apply. (T) This is called the Euler method. (U) In industry, there are better methods. (V) The loop runs for about 100000 iterations. (W) `t` is casted into an `int` before comparing to `10`.

[74] Select the true statement. (X) `break` will break the inner-most loop. (Y) `continew` will skip to the next iteration of the inner-most loop. (Z) `fbreak` will break for-loop and ignore while-loop. (A) `wbreak` will break while-loop and ignore for-loop.

```
int S = 0;
for (int i = 0; i < 20000000; i++) {
    for (int j = 0; j < 20000000; j++) {
        if (rand() % 17) { S++; }
    }
}
```

[75] How long does it take to run the loop above? (B) about 1–10 microseconds (C) about 1–10 seconds (D) about 1–10 days (E) about 1–10 years

[76] When we have nested for loop like above, what should we do to monitor its progress? (F) Add `cout << t` in the inner loop. (G) Add `cout << t` in the outer loop. (H) print a dot for every one thousand iterations. (I) Use a debugger to manually step through the code.

[77] Select the two correct declarations so that we can use `A[j][j]` to access the entry of a matrix `A` of size 100x200. (J) `int A[100][200] = {};` (K) `int A = new int[100][200];` (L) `int **A = new int[100][200];` (M) `int (*A)[200] = new int[100][200];`

```
#include <iostream>
#include <random>
using namespace std;
int main () {
    mt19937 rand(20251022);
    mt19937 rane(20251022);
    mt19937 ranf(20251022);
    cout << rand() << rand() << rand() << endl;
    cout << rane() % 16 << endl;
    cout << ranf() % 16 << endl;
    cout << rane() * ranf() % 16 << endl;
    cout << ranf() * rane() % 16 << endl;
}
```

[78] The first line of the output is `213642482215617769593640112 0`. What is the second line of output?

[79] What is the third line of output?

[80] What is the fourth line of output?

[81] What is the fifth line of output?

[82] Use `a`, `b`, `c`, `d`, `x`, `add(,)`, and `mul(,)` to express cubic polynomial $ax^3 + bx^2 + cx + d$. Use the minimum number of `add` and `mul`.

```
float i(float x) { return 10 * x + 1; }
float i(int x) { return 10 * x + 2; }
int f(float x) { return 10 * x + 3; }
int f(int x) { return 10 * x + 4; }
```

[83] What is `f(f(i(5)))`?

[84] What is `f(f(i(i(f(f(i(5.f)))))))`?

```
int a = 1, b = 3, c = 2;
int *p = &a, *q = &b, *r = &c;
int **x = &p, **y = &q, **z = &r;
cout << **x << **y << **z << endl;
swap(x, y);
cout << **x << **y << **z << endl;
swap(a, c); swap(q, r);
cout << **x << **y << **z << endl;
swap(*x, *z);
cout << **x << **y << **y << endl;
swap(*p, *q); swap(**y, **z);
cout << **x << **y << **z << endl;
```

[85] For the code to the right, what is the first line of output?

[86] What is the second line of output?

[87] What is the third line of output?

[88] What is the fourth line of output?

[89] What is the fourth line of output?

[90] `1*a**p***x` is?

[91] A private member function (N) can be called by any function (even outside the class) (O) can be called by other member functions of the same class (P) cannot access private member variables (Q) cannot access public member variables

[92] Finish the function that shifts the center of the circle by `(x, y)`. (Note that `c` is passed by reference so you can just modify `c`.)

```
struct Circle { float x, y, r; };
void Shift (struct Circle& c, float x, float y)
    {/*your code here*/}
void Rotate (struct Circle& c, float r)
    {/*your code here*/}
```

[93] Finish the function that rotates the circle by `r` radians (the default unit for trigonometric functions) about the origin.

[94] I want to compute the maximum `maxA` of an integer array `A` of length `100`. What should `/*prepare-before*/` be

```
int A[100];
/*computation for A*/
/*prepare-before*/
for (int i = 0; i < 100; i++) { /*in-loop*/ }
```

[95] What should `/*in-loop*/` be?

[96] If, instead of maximum, I want to check if at least 5 elements of `A` are greater than `10`, what should `/*prepare-before*/` be?

[97] What should `/*in-loop*/` be?

[98] After the loop, I should let `bool check5gt10 = ?`

[99] C# (where # is pronounced `sharp` and stands for four plus signs) (R) 1970 (S) 1980 (T) 1990 (U) 2000

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Name (zh or en) Student ID

[1] [2] [3] [4] [5] [6] [7] [8] [9] [10] [11] [12] [13] [14] [15] [16] [17] [18] [19] [20] [21] [22] [23] [24] [25]

[26] [27] [28] [29] [30] [31] [32] [33] [34] [35] [36] [37] [38] [39] [40] [41] [42] [43] [44] [45] [46] [47]

[48] [49] [50] [51] [52] [53] [54] [55] [56] [57] [58]

[59] [60] [61] [62]

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[69] [70] [71] [72] [73] [74] [75] [76]

[77] [78] [79] [80] [81] [82] [83] [84]

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