Programming

A-Level Computer Science

Programming basics

```
1 usage
public Hotel (Integer capacity) { this.capacity = capacity; }
1 usage
public synchronized boolean checkIn(AccommodationRequest request) {
    if (guests.size() < capacity) {
        guests.add(request);
        return true;
    }
    else {
        return false;
    }
}
```

Programming turns a design into instructions written as code

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A programmer writes the code and tests it as they go

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From design to code

You should be able to turn a design —a **flowchart** 流程图 or **structured English** 结构化英语—into **pseudocode** 伪代码, and then into a real language:

1. find the **variables** 变量 and their **data types** 数据类型.
2. turn input/output boxes into `INPUT` / `OUTPUT`.

3. turn decision diamonds into `IF...ELSE...ENDIF` (or `CASE`).
4. turn loop arrows into `WHILE`, `REPEAT...UNTIL`, or `FOR`.
5. turn process boxes into assignments or calculations.
6. check by tracing a small input.

Constants and variables

A **constant** 常量 holds a value that **never changes**; a variable holds one that may change. Declare them with a type:

```
CONSTANT Pi ← 3.14159
DECLARE Radius : REAL
DECLARE Area : REAL

Radius ← 5
Area ← Pi * Radius * Radius
```

Use constants for fixed values that recur (`Pi`, `MaxScore`); they make code clearer and easy to change in one place.

Assignment and expressions

Use ← for **assignment** 赋值:

```
Total ← Total + 1
Average ← Sum / Count
```

Expressions use **operators** 运算符:

- arithmetic `+ - * /`, plus `DIV` (integer division) and `MOD` (remainder): `7 DIV 2 = 3`; `7 MOD 2 = 1`.
- comparisons `=`, `<>`, `<`, `>`, `<=`, `>=`.
- logic `AND`, `OR`, `NOT`.

Precedence 优先级 (highest to lowest): `NOT` → `* / DIV MOD` → `+ -` → comparisons → `AND` → `OR`. Use brackets when unsure.

Input and output

```
OUTPUT "Enter your name:"
INPUT Name
OUTPUT "Hello, ", Name
```

Built-in functions and library routines

Many tasks have ready-made **library routines** 库例程, so you need not write them:

- string: `LENGTH(s)`, `LEFT(s, n)`, `RIGHT(s, n)`, `MID(s, start, len)`, `UCASE(s)`, `LCASE(s)`.
- numeric: `INT(x)`, `ROUND(x)`, `ABS(x)`, `MOD(a, b)`, `RANDOM()`.

- conversion: `STR(x)` (number → string), `VAL(s)` (string → number).

Use the exact names from the question paper's reference list.

Selection

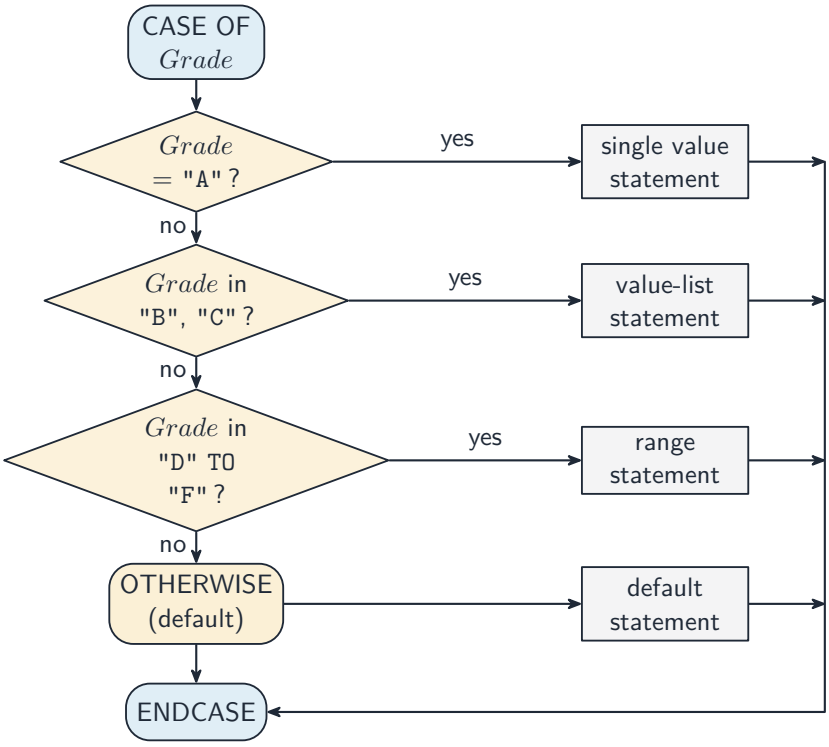
Selection 选择 chooses which steps run.

```
IF age >= 18 THEN
    OUTPUT "Adult"
ELSE
    OUTPUT "Minor"
ENDIF
```

For more than two cases you can use a **nested** 嵌套 IF, but deep nesting is hard to read —a `CASE` is cleaner when testing one value against several options:

```
CASE OF Grade
    "A": OUTPUT "Excellent"
    "B": OUTPUT "Good"
    OTHERWISE: OUTPUT "Try again"
ENDCASE
```

Cambridge `CASE` allows single values, value lists (`1, 2, 3:`), and ranges (`1 TO 5:`).



A CASE statement runs the branch that matches the value

Iteration

Iteration 迭代 repeats a block. Three loops differ in how many times the body runs.

Count-controlled (FOR) loop

A **count-controlled loop** 计数循环—use it when you know how many times to repeat:

```
FOR i ← 1 TO 10
    OUTPUT i
NEXT i
```

A `STEP` can change the count (e.g. `FOR i ← 10 TO 1 STEP -1`). Best for a fixed number of repeats or processing each element of an **array** 数组.

Pre-condition (WHILE) loop

A **pre-condition loop** 前测循环 tests the condition **before** each pass, so it may run **zero** times:

```
WHILE total < 100 DO
    INPUT n
    total ← total + n
ENDWHILE
```

Post-condition (REPEAT...UNTIL) loop

A **post-condition loop** 后测循环 tests the condition **after** each pass, so it always runs **at least once**:

```
REPEAT
    INPUT password
UNTIL password = correctPassword
```

Choosing the right loop

- count known up front → **FOR**.
- may need zero passes → **WHILE**.
- always at least one pass → **REPEAT...UNTIL**.

Justify your choice by whether the count is known and whether the body must run at least once. A typical question gives a scenario ("ask for a password until correct, but always ask at least once") and asks which loop fits.

Procedures and functions

Structured programming 结构化编程 builds a program from small named **subroutines** 子程序, each with one job.

Procedure

A **procedure** 过程 is a named block that **does an action**; it may take **parameters** 参数 but does **not return a value**.

```
PROCEDURE Greet(name : STRING)
    OUTPUT "Hello, ", name
ENDPROCEDURE

CALL Greet("Ada")
```

Function

A **function** 函数 is like a procedure but it **returns a value** that becomes part of an expression.

```
FUNCTION Square(x : INTEGER) RETURNS INTEGER
    RETURN x * x
ENDFUNCTION

result ← Square(5) + 1     // result = 26
```

Use a **procedure** when the subroutine performs an action; use a **function** when it computes a value for the caller.

Parameters

A **parameter** is a variable a subroutine declares to receive input; the values the caller supplies are **arguments** 实参. Two ways to pass them:

- **pass by value** 传值—the routine gets a **copy**; changes inside it do not affect the caller. Use for inputs it only reads.
- **pass by reference** 传引用—the routine gets a **reference** to the caller's variable; changes **do** affect the caller. Use when it must update a parameter.

```
PROCEDURE Swap(BYREF a : INTEGER, BYREF b : INTEGER)
    DECLARE temp : INTEGER
    temp ← a
    a ← b
    b ← temp
ENDPROCEDURE
```

Local vs global variables

A **local variable** 局部变量 is declared inside a subroutine and exists only while it runs. A **global variable** 全局变量 is declared outside and is visible everywhere. Prefer locals and parameters —heavy use of globals makes code hard to follow and test. (The region where a name is visible is its **scope** 作用域.)

When to use a subroutine

Use one when the same logic appears in **more than one place**, when a block has a **clear named purpose**, when the program is **complex** (use **decomposition** 分解), or when you want to **test a piece in isolation**. Don't make them so tiny that the call costs more than the content.

Terminology

- **definition** —the `PROCEDURE ... ENDPROCEDURE` (or function) block.
- **call** —where it is invoked. **argument** —a value passed in. **parameter** —the variable that receives it.
- **return value** —what a function passes back.
- **signature** 签名—name + parameters + return type.

Writing efficient pseudocode

- **move invariants out of loops** —if a value (an **invariant** 不变量) does not change with the loop counter, compute it once before the loop.
- **exit a loop early** when the answer is found (stop a **linear search** 线性查找 as soon as the target appears).
- **avoid redundant work** —store a result and reuse it instead of recomputing.
- **choose the right data structure** —an array beats many separate variables when the items belong together.
- **replace deep nested IFs with CASE** when testing one value against many.
- **comment the intent**, not the mechanics (`// validate the postcode`, not `// loop 6 times`).
- **use meaningful names** (`numberOfPupils`, not `n`) and **initialise variables** before use.