

4.2 Assembly Language

Name: _____ Class: _____ Date: _____ **Total: 19 marks**

KEY WORDS assembly language 汇编语言 • assembler 汇编器 • machine code 机器码
• addressing mode 寻址方式 • index register 变址寄存器

Objective

Build the skills to answer exam questions on **assembly language** 汇编语言 — how it relates to machine code, the two-pass assembler, the modes of addressing, and tracing a program.

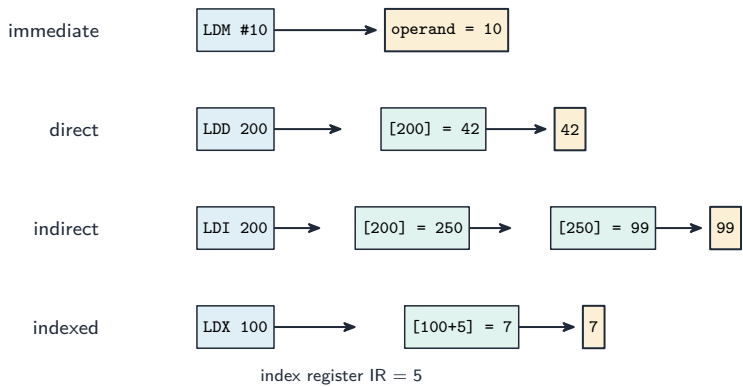
You must be able to:

- explain the relationship between **assembly language** and **machine code** 机器码
- describe the stages of a **two-pass assembler**
- use the **modes of addressing** (immediate, direct, indirect, indexed)
- **trace** a simple assembly-language program

1 Worked examples

Study these first. Each one shows the method for a question type used later — follow the steps and you can do the Practice and Exam-style questions yourself.

■ Assembly, machine code and the assembler



Assembly instructions use addressing modes to locate their operands

The CPU runs **machine code** (binary). **Assembly language** is a readable form — one **mnemonic** 助记符 (like LDD, ADD) per machine instruction. An **assembler** translates it. A **two-pass assembler** reads the source twice:

- **Pass 1** builds a **symbol table** — it records the address of every **label** (e.g. LOOP:).
- **Pass 2** generates the code — and when an instruction uses a label (e.g. JMP LOOP), it looks the address up.

Two passes are needed for **forward references** — a jump to a label that is defined *later* in the code.

■ Modes of addressing

The addressing mode says **how the operand is found**:

Mode	The operand is...	Example
immediate	the value in the instruction	LDM #10 → loads 10
direct	the value at the given address	LDD 200 → loads contents of 200
indirect	at the address <i>stored</i> at the given address	LDI 200
indexed	at address + index register (IX)	LDX 100, IX = 5 → reads 105

■ Common instructions

You will also meet these in traces (the exam gives the full list):

Mnemonic	What it does
STO <addr>	store the ACC into the address
ADD / INC / DEC	add to / add 1 to / subtract 1 from
CMP <addr>	compare the ACC with the contents of the address
JMP / JPE / JPN	jump always / jump if the last compare was equal / not equal
IN / OUT	input / output one character (its ASCII value)
END	stop the program

■ Tracing a program

Make a table with a column for the **ACC** and for each variable, then step through, updating after each instruction. Trace this (start: **num1** = 6, **num2** = 9):

Instruction	ACC	total
LDM #0	0	
STO total	0	0
LDD num1	6	0
ADD num2	15	0
STO total	15	15

So **total** ends as **15**.

2 Practice

Now apply the methods above.

2.1 State the difference between **assembly language** and **machine code**. [2]

2.2 State what each instruction loads into the ACC: (a) LDM #20 (b) LDD 20. [2]

2.3 Explain why an assembler needs **two passes**. [2]

2.4 LDX 100 is executed when the index register IX = 4. State which address is read. [1]

3 Exam-style questions

3.1 (a) Describe what happens in **pass 1** and in **pass 2** of a two-pass assembler. [4]

(b) State why two passes are needed. [1]

3.2 Explain the difference between **immediate**, **direct** and **indirect** addressing. [3]

3.3 Trace this program (start: **a** = 10, **b** = 4) and complete the table. [3]

Instruction	ACC	c
LDD a		
ADD b		
STO c		
END		

3.4 Give one reason a programmer might write part of a program in assembly language rather than a high-level language. [1]