Unit 4 · From Code to Circuits

WORKSHEET

Full marks 33

Name _____ Class _____ Roll no. ____ Date _____ Marks _____ / 33

1 Key words [4]

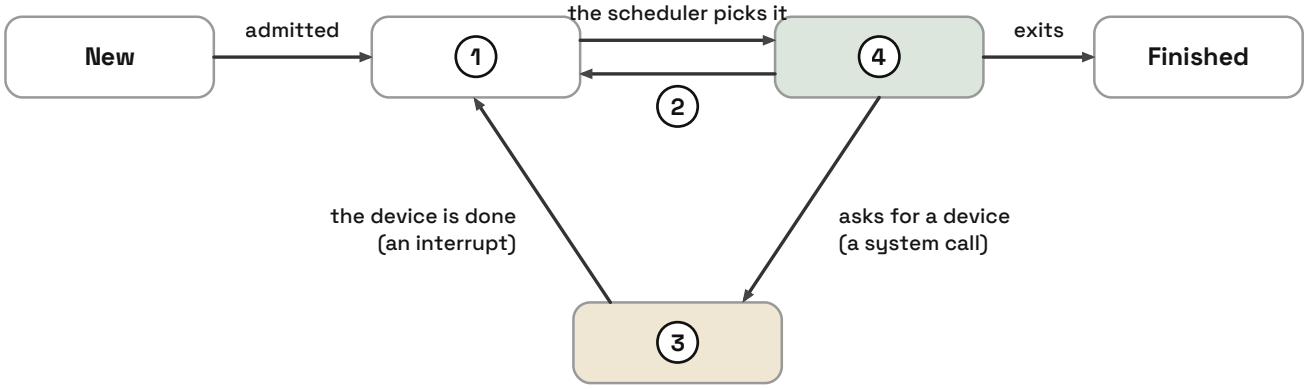
Fill in the blanks with words from the box. Two words in the box are not needed. Each blank carries 0.5 mark.

compiler	flip-flop	mask	opcode	pixel	program counter	registers	router	scheduler	threads

The processor works on numbers held in its _____, and the _____ holds the address of the next instruction. In machine code, the first hex digit of each instruction is its _____. A number with 1s only in the bits a program wants to look at is a _____. A _____ stores one bit, and changes it only when the clock ticks. A _____ translates a whole program before it runs. The operating system's _____ decides which process runs next, and two _____ of one process share its memory.

2 Label the diagram [2]

The diagram shows the states of a process. Write the word or words that belong in place of 1 to 4. Each carries 0.5 mark.



1. _____ 2. _____

3. _____ 4. _____

3 Multiple choice [4]

Choose the correct option for each of the following questions.

i. In our processor's machine code, what is **7201**? [1]

a. SUB R1, #2
b. SUB R2, #1
c. STORE R2, 1
d. ADD R2, #1

ii. R0 holds 5 (0000 0101). What does it hold after `LSL R0, #3`? **[1]**

a. 8 **b.** 15

c. 40 **d.** 0

iii. What is the **Von Neumann bottleneck**? **[1]**

a. a processor with too few registers

b. instructions and data sharing one path to memory, so they must take turns on it

c. the stack growing down into the program

d. a slow clock

iv. In the 8-bit format of this unit (1 sign, 4 exponent bits with bias 7, 3 mantissa bits), what is **0 1000 100**? **[1]**

a. 1.5 **b.** 3

c. 6 **d.** 12

4 Trace the program **[4]**

The program runs on the processor of this unit. Fill in a row each time `CMP` has been carried out, then what the program shows. Then answer.

```
1         MOV R0, #0
2         MOV R1, #4
3 loop:   ADD R0, R1
4         SUB R1, #1
5         CMP R1, #0
6         BGT loop
7         OUT R0
8         HALT
```

i. Fill in the table.

R0	R1	Flag	Output

ii. How many instructions does the processor carry out in all, counting HALT?

5 Masks [3]

The inverter's status register has bit 0 "on battery", bit 1 "charging", bit 2 "battery low" and bit 3 "overload". Its status is **0000 0110**.

i. What does the status say?
ii. Which operation and mask switch bit 3 on? Write the status after it.
iii. Which operation and mask switch bit 2 off, starting again from 0000 0110? Write the status after it.

6 Write a program [4]

Use the instructions and machine code of this unit. Write the program in assembly language on the left, and each instruction's machine code beside it.

Write a program that shows 2, 4, 6, 8 and 10, then stops. Use a label for the loop, and give the machine code of every instruction (the first instruction is at address 0).

7 Taking turns [4]

Answer in the box. Waiting time = finishing time − arrival time − time needed.

Four processes share one core: P arrives at 0 ms and needs 5 ms, Q at 1 ms needs 2 ms, R at 2 ms needs 6 ms, and S at 3 ms needs 1 ms.

i. Under first come, first served (FCFS), when does each process finish? Work out the average waiting time.
ii. Do the same under shortest job first (SJF, non-preemptive).

Answer:

8 Simplify the circuit [3]

Answer on the lines. $\overline{A}$ means NOT A.

A light is on when $L = \overline{A}{\cdot}B + A{\cdot}\overline{B} + A{\cdot}B$.

i. Simplify L with the rules of Boolean algebra. Name each rule you use.
ii. The light is off when NOT (A + B). Use De Morgan's law to write this with bars over single letters only.

9 A float in 8 bits [3]

This unit's 8-bit format: 1 sign bit, 4 exponent bits (bias 7), 3 mantissa bits after a hidden 1.

i. Write 6.5 in this format.
ii. What number is **1 1001 010**?
iii. Why can't 0.1 be stored exactly in any binary float?

10 Think [2]

Think, then answer.

Two threads of one program each add 1 to a shared counter, with LOAD, ADD and STORE. The counter starts at 5. Usually it ends at 7, but now and then at 6. Explain, with an order of the steps, how it can end at 6, and how the program can make sure it always ends at 7.

11 Activity: Four ways to choose (not marked)

At a computer, open the unit's page (the QR code) and find **Four ways to choose.** Try each rule, then fill in the table.

Rule	Average waiting time	Longest wait, and whose
FCFS		
SJF		
SRT		
Round robin		