



University of Kelaniya – Sri Lanka
Centre for Distance and Continuing Education
Bachelor of Science (External) Second Year Second Semester- 2023
2026 – July
Faculty of Science
Computer Architecture and Operating Systems
COSC 27573/COSC 27573 (R)

No of Questions: Four (04)

No. of pages: Four (04)

Time: Two and a half (02½) Hours

Answer ALL Questions

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- 1.
- (a.)
- (i.) What is Computer Architecture? (5 Marks)
- (ii.) Explain the Von Neumann Architecture. (5 Marks)
- (iii.) What is the Von Neumann Bottleneck? Discuss its causes and explain how modern architectures attempt to overcome it. (10 Marks)
- (b.)
- (i.) Explain the Instruction Execution Cycle. (15 Marks)
- (ii.) Explain the purpose and usage of the following CPU registers. (20 Marks)
- A. Instruction Register (IR)
- B. Program Counter (PC)
- C. Memory Address Register (MAR)
- D. Memory Data Register (MDR)
- (iii.) Using the instruction execution cycle and the above registers, list the necessary steps to execute the machine instruction (15 Marks)
- SUB R1 R2 R3**
- (c.)
- (i.) Write the Basic Performance Equation and define each of its terms (T, N, S and R). (5 Marks)
- (ii.) Two systems execute the same program with 5000 instructions. System A has an average of 5 steps per instruction and runs at 2.5 million steps per second. System B has an average of 4 steps per instruction but runs at 2 million steps per second.

(25 Marks)

- A. What is the execution time of the program on System A?
- B. What is the execution time of the program on System B?
- C. Which system is faster, and by how much in terms of execution time?

2.

(a.)

- (i.) What is an Instruction Set Architecture (ISA)?

(5 Marks)

- (ii.) Write the basic steps needed to perform compilation of the following statement using the following ISA types:

$$Y = ((A-B) * (C-D)) / E$$

(30 Marks)

- A. Accumulator-based ISA
- B. Stack-based ISA
- C. Register-memory ISA (with two operands)

- (iii.) List three addressing modes and briefly explain any two of them.

(10 Marks)

(b.)

- (i.) Compare and contrast combinational circuits and sequential circuits in terms of their structure, behavior, and memory characteristics.

(5 Marks)

- (ii.) Draw the truth table and a detailed logic diagram for each of the following circuits:

(40 Marks)

- A. Half subtractor
- B. Full subtractor
- C. Half adder
- D. Full adder

- (iii.) Using the Full subtractor truth table complete the following table for the subtraction of $1011_2 - 0100_2$. Also, write down the final answer using the filled table. (the first row is filled for you)

(10 Marks)

Bit Position	A	B	Borrow in	Difference	Borrow out
LSB	1	0	0	1	0
1					
2					
MSB					

3.

(a.)

- (i.) What is an Operating System?

(5 Marks)

- (ii.) Briefly describe each of the following terms:

(20 Marks)

- A. Hardware

- B. Kernel
- C. Shell
- D. User Applications

(iii.) What is the Hardware Abstraction Layer (HAL) in an Operating System? Explain its advantages.

(10 Marks)

(b.)

(i.) Draw a diagram illustrating the process life cycle, and briefly explain each state.

(10 Marks)

(ii.) What is a Process Control Block (PCB), and what information does it store?

(10 Marks)

(iii.) Explain the context-switching process in a multitasking system and the role of the PCB in this process.

(10 Marks)

(iv.) Get the output of the following code and explain how the output is generated, using a diagram.

(20 Marks)

```
#include <stdio.h>
#include <unistd.h>
int main() {
    printf("Hello UOK.\n");
    fork();
    printf("Hello UOK.\n");
    fork();
    printf("Hello UOK.\n");
    return 0;
}
```

(c.)

(i.) What is Inter-Process Communication (IPC), and why is it necessary in operating systems?

(5 Marks)

(ii.) Describe the following two models used in Inter-Process Communication (IPC):

(10 Marks)

- A. Message-Passing Model
- B. Shared Memory Model

4.

(a.)

(i.) What is meant by process scheduling, and what is the role of the process scheduler in an operating system?

(10 Marks)

(ii.) Briefly describe the function and use of each of the following scheduling queues:

(15 Marks)

- A. Job Queue
- B. Ready Queue
- C. Device Queue

- (iii.) Explain why both short-term and long-term schedulers are used in process management and describe their respective roles.

(10 Marks)

(b.)

- (i.) Explain the difference between preemptive and non-preemptive scheduling.

(10 Marks)

- (ii.) For the given set of processes below, calculate the average waiting time and average turnaround time using each of the following scheduling algorithms. Assume that all processes arrive at time zero and are initially arranged in the ready queue as shown.

(30 Marks)

- A. First-Come, First-Served (FCFS)
B. Shortest-Job-First (SJF)
C. Round Robin (RR) scheduling with time quantum $q = 3$.

Process	Burst Time
P1	5
P2	8
P3	1
P4	4
P5	3

- (iii.) Consider the following set of processes:

(25 Marks).

Process	Arrival Time	Burst Time
P1	0	10
P2	4	5
P3	5	3
P4	6	1

Using Shortest Remaining Time First (SRTF) scheduling, answer the following questions

- A. Draw the Preemptive Gantt Chart?
B. Calculate the average waiting time?
C. Calculate the average turnaround time?
D. Calculate the throughput in 10-time units?

*** END OF PAPER ****