

ICT2202 - Operating Systems

Model Paper 2024

Duration 150 minutes

Instructions to Candidates

01. This paper 05 questions on 03 pages (from page 2 to 3).
02. You should answer all 04 questions.
03. Questions should be answered according to the order that they appear on the question paper.
04. Clearly write your index number (do not write your name or student ID) on the examination booklet, supplementary answer sheets and the question paper.
05. Write your answers in the examination answer booklet provided and all answers to a new question should start on a new page.
06. Clearly write the question number on the left side margin of the answer sheet.
09. Non Programmable Calculator are allowed
10. This is a closed book examination.

Question 1

[Total – 20 marks]

a) Write an Example for each of the following operating systems

- i. Server Operating System
- ii. Mobile Operating System

[1.0 × 2 = 2.0 marks]

Answer

- i. Any one (1) of Windows Server, Red Hat Enterprise Linux (RHEL), etc.
- ii. Any one (1) of Android, iOS, etc.

b) List three (3) functionalities of the BIOS firmware.

[1.0 × 3 = 3.0 marks]

Answer

Any three (3) of,

- Power-on Self-Test
- System Configuration
- Bootstrap Loader
- Hardware Abstraction
- BIOS Setup Utility
- Power Management
- Firmware Updates

c) Briefly explain each of the following duties of the Operating System.

- i. Process Management
- ii. Device Management

[2.0 × 2 = 4.0 marks]

Answer

- i. Process management is responsible for handling running programs efficiently. The OS creates processes when a program starts and terminates them when they complete or crash. It also manages how processes share CPU time.
- ii. Device management controls and coordinates hardware devices such as keyboards, printers, and storage drives. The OS allocate devices to processes, translate general commands into device-specific instructions using drivers and releases when done. It also manages the order in which device requests are processed to optimize performance.

- d) Operating systems use a dual-mode (Kernel/User) operation to provide security and stability. Following paragraph describes how operating system controls application programs from directly interfering with critical system functions. Fill in each of the blanks appropriately.

The operating system begins in(i)..... during boot-up, enabling it to initialize hardware and system processes. When a user launches an application, it runs in(ii)....., where access to system resources is restricted for security and stability. If the application requires a system service such as reading a file or allocating memory, it makes a(iii)....., requesting the operating system's assistance. The OS then switches to(iv)..... to execute the requested operation. Once the task is completed, control is returned to(v)....., allowing the application to resume execution safely.

[1.0 × 5 = 5.0 marks]

Answer

- i. kernel mode ①
- ii. user mode ①
- iii. system call ①
- iv. kernel mode ①
- v. user mode ①

- e) Consider the following bootloader code written in assembly to answer each of the questions below.

```
mov ah, 0x0E
mov cx, 5
print:
mov al, 0x41 ; ASCII for A
int 0x10
loop print
times 510 - ($-$$) db 0
dw 0xAA55
```

- i. What is the importance of 'dw 0xAA55' in this code? [1.0 marks]
- ii. Explain the code segment 'times 510 - (\$-\$\$) db 0'. [3.0 marks]
- iii. What is the output of this code? [2.0 marks]

Answer

i. BIOS validates Master Boot Record should contain the boot signature as the last two bytes ❶.

ii. \$\$ and \$ represent the starting address of the bootloader and current address respectively ❶.

Therefore, \$-SS represents the size of the code ❶. By subtracting it from the 510 we make sure the rest of the code up to 510 bytes will be filled with 0 ❶.

iii. 'AAAAA' ❷

Question 2

[Total – 20 marks]

a) Name two types of memory that are faster but smaller in capacity than the main memory.

[1.0 × 2 = 2.0 marks]

Answer

Registers ①

Cache memory ①

b) Name three (3) pieces of information included in the \$BOOT data structure in NTFS file System.

[1.0 × 3 = 3.0 marks]

Answer

Any three (3) of, ③

- Number of bytes per sector
- Number of sectors per cluster
- Starting cluster of \$MFT data structure
- Size of the \$MFT record, etc.

c) Pages are stored initially on a disk having access time 150 ms. Pages are loaded to the memory having an access time 50 s as they are requested. In case of a page fault, page is first loaded to the memory and then served. Answer each of the following questions based on this description.

- i. How much time will it take to retrieve a page from the disk?
- ii. What is the average access time of the system if the fault probability is 0.1?

[2.0 × 2 = 4.0 marks]

Answer

i. $150 + 50$ ① = 200 ms ①

ii. $(1 - 0.1) \times 50 + 0.1 \times 200$ ① = 65 ms ①

d) List five (5) limitations in a 'MBR' disks when compared to a 'GPT' disk. [1.0 × 5 = 5.0 marks]

Answer

Any five (5) of, ⑤

- Supports only up to 4 primary disks.
- 2 TB disk size limitation
- 2 TB partition size limitation
- 446 B bootstrap code limitation
- 512 small sector size
- Boot Mode Compatibility is limited to BIOS
- Less Support for modern OS features, etc.

e) Consider the following tables representing the structure of the partition entry in DOS partition table and a hex dump representing the partition table of a disk of size 3.75 GB to answer each of the questions given below.

Offset (Hex)	Length (Bytes)	Description
0x00	1	Boot Flag
0x01	3	Starting CHS
0x04	1	Partition Type
0x05	3	Ending CHS
0x08	4	Starting LBA
0x0C	4	Size in Sectors

0002	0300	0E8C	0A82	8000	0000	0000	2000
008C	0B82	07D1	0EC3	8000	2000	0000	1000
00D1	0FC3	0C74	10E4	8000	3000	0000	0800
0000	0000	0000	0000	0000	0000	0000	0000

- How many partitions are there in this disk? [1.0 marks]
- Is this disk bootable? Justify your answer. [1.0 + 1.0 = 2.0 marks]
- Find the unallocated space of the disk in sectors. [3.0 marks]

Answer

i. Three (3) ③

ii. No ①. Boot flag of a bootable partition should be 0x80. But boot flags of each partition in this disk is 0x00 indicating that all of them are non-bootable ①.

iii. $3.8\text{ GB} - (1024\text{ MB} + 512\text{ MB} + 256\text{ MB})$ ① $= 2\text{ MB} = \frac{2\text{ MB}}{512\text{ B}}$ ① $= 4096\text{ sectors}$ ①

Question 3

[Total – 20 marks]

- a) List two (2) problems in segmented memory due to variable size segments. [1.0 × 2 = 2.0 marks]

Answer

Any two (2) of, ②

- Complex physical address calculations
- Starvation for large segments
- Free memory fragmentation

- b) In segmented memory mode, calculate the physical address if the segment register and offset register contains 0x2010 and 0xFF10. [3.0 marks]

Answer

20100 ① + FF10 ① = 0x30010 ①

- c) Briefly explain each of the following terms in page based memory.

i. Virtual Memory

ii. Logical Memory

[2.0 × 2 = 4.0 marks]

Answer

i. Virtual memory is a memory management technique that allows a computer to execute processes that require more memory than the available physical RAM ①. It achieves this by using a portion of the hard disk (swap file) as an extension of RAM ①.

ii. Logical memory refers to the address space assigned to a process by the operating system. It is generated by the CPU and is independent of the actual physical memory ①. Logical addresses are mapped to physical memory addresses by the Memory Management Unit (MMU) using paging or segmentation ①.

A physical memory has 2 page frames and initially both of them are empty. Consider the following sequence of page requests: < 1, 1, 2, 1, 3, 2 > to answer each of below.

- d) What is the final state of the frames under each of the following page replacement algorithms?

i. Least Recently Used (LRU)

ii. First In First Out (FIFO)

iii. Least Frequently Used (LFU)

[2.0 × 3 = 6.0 marks]

Answer

i. ①

2	3
---	---

 ①

ii. ①

3	2
---	---

 ①

iii. ①

1	2
---	---

 ①

e) Calculate the hit probability for each of the algorithms in part d. Hence, decide the best page replacement algorithm for the above sequence of request. [1.0 × 3 + 2.0 = 5.0 marks]

Answer

$$Hit(LRU) = \frac{2}{6} \approx 33\% \text{ ①}$$

$$Hit(FIFO) = \frac{3}{6} = 50\% \text{ ①}$$

$$Hit(LFU) = \frac{2}{6} \approx 33\% \text{ ①}$$

Therefore, for the given sequence of page requests, the best page replacement algorithm is FIFO ②.

Question 4

[Total – 20 marks]

a) List two (2) issues in FCFS Scheduling.

[1.0 × 2 = 2.0 marks]

Answer

Any two (2) of, ②

- Convoy Effect (If a long process arrives first, it will block the execution of shorter processes)
- Non-preemptive
- Lack of Prioritization
- High Average Waiting Time

b) What is preemptive scheduling? Give two (2) examples for preemptive scheduling techniques.

[1.0 + 2.0 = 3.0 marks]

Answer

Preemptive scheduling is a CPU scheduling technique where the operating system can interrupt a running process and allocate the CPU to another process while placing the interrupted process in ready queue ①.

Any two (2) of, ②

- Round Robin (RR)
- Shortest Remaining Time First (SRTF)
- Preemptive Priority Scheduling

c) In Round Robin (RR) scheduling, the selection of time quantum is crucial for system performance.

Discuss the effects of choosing a time quantum that is:

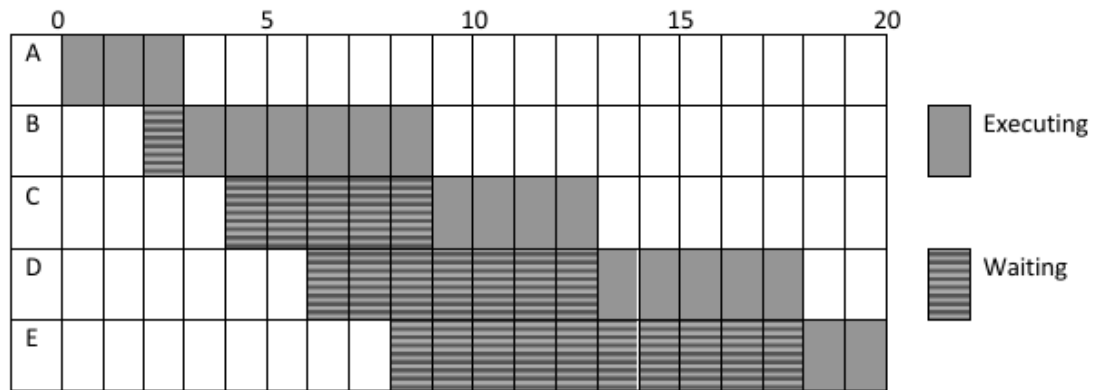
- Too small
- Too large

[2.0 × 2 = 4.0 marks]

Answer

- The CPU frequently switches between processes ①, increasing **overhead** for context switching that reduces efficiency ①.
- The scheduling behaves more like **First-Come, First-Served (FCFS)** ①, as processes run for long periods without interruption resulting prolonged response time ①.

Consider the following Gantt chart representing the First Come First Serve (FCFS) scheduling of five (5) processes A, B, C, D and E to answer the questions below.



d) Calculate each of the following criteria.

- i. Average turnaround time
- ii. Average response time
- iii. Average waiting time
- iv. Idle time of the CPU
- v. Throughput

[1.0 × 5 = 5.0 marks]

Answer

i. $\frac{3+7+9+12+12}{5} = \frac{43}{5} = 8.6$ ①

ii. $\frac{0+1+5+7+10}{5} = \frac{23}{5} = 4.6$ ①

iii. 4.6 ①

iv. 0 ①

v. $\frac{5}{20} = 25\%$ ①

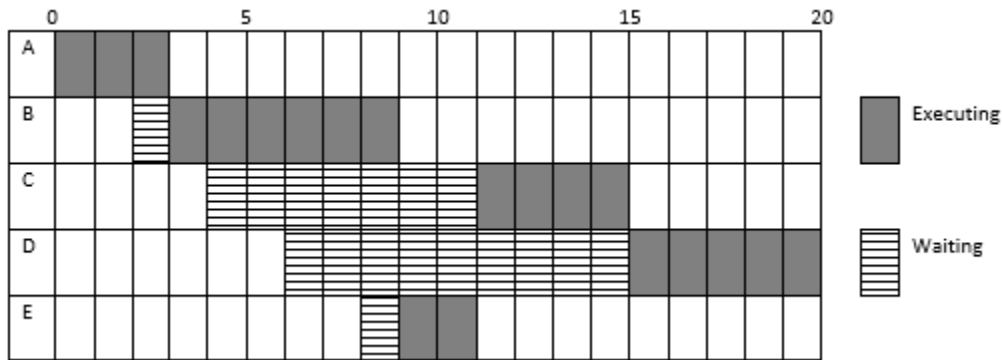
e) Draw Gantt chart for the same processes if each of the following Scheduling techniques were used.

- i. Shortest Job First (SJF)
- ii. Shortest Remaining Time First (SRTF)

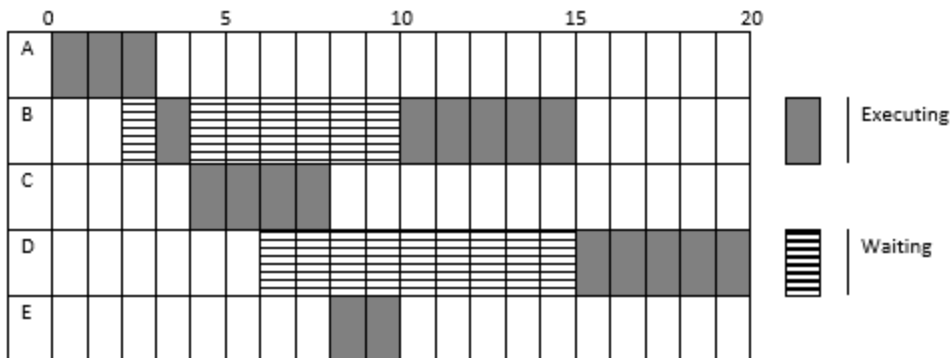
[3.0 × 2 = 6.0 marks]

Answer

i. For the correct diagram, ③



ii. For the correct diagram, ③



Question 5

[Total – 20 marks]

a) Name two (2) popular public cloud providers.

[1.0 × 2 = 2.0 marks]

Answer

Any two (2) of, ②

- Amazon Web Services (AWS)
- Microsoft Azure
- Google Cloud Platform (GCP)

b) Name 3 methods that you can run Ubuntu on your laptop having windows operating system.

[1.0 × 3 = 3.0 marks]

Answer

Any three (3) of, ③

- Dual Boot (Ubuntu & Windows)
- Virtual Machine (VM)
- Windows Subsystem for Linux (WSL)
- Live USB (Without Installation)
- Persistence portable disk

c) Briefly explain each of the following terms related to virtualization.

- i. Hypervisor
- ii. Virtual Hard Disk

[2.0 × 2 = 4.0 marks]

Answer

i. A hypervisor is a software layer that enables virtualization by allowing multiple virtual machines (VMs) to run on a single physical machine (host) ①. It abstracts and manages the hardware resources, allocating them to each VM as needed ①.

ii. A Virtual Hard Disk (VHD) is a file that acts as a hard drive for a virtual machine ①. It stores the VM's operating system, applications, and data, mimicking a physical hard disk ①.

- d) Complete the following table that illustrate the cloud service models by indicating CONSUMER or PROVIDER appropriately in the blanks.

	On Premises	PaaS	SaaS	IaaS
Application	CONSUMER	(ii)	(vi)	CONSUMER
Data	CONSUMER	(iii)	(vii)	CONSUMER
Runtime	CONSUMER	(iv)	PROVIDER	CONSUMER
Middleware	CONSUMER	(v)	PROVIDER	(viii)
OS	CONSUMER	PROVIDER	PROVIDER	(ix)
Virtualization	CONSUMER	PROVIDER	PROVIDER	(x)
Servers	CONSUMER	PROVIDER	PROVIDER	PROVIDER
Storage	CONSUMER	PROVIDER	PROVIDER	PROVIDER
Networking	(i)	PROVIDER	PROVIDER	PROVIDER

[0.5 × 10 = 5.0 marks]

Answer

For each correct answer, (1/2)

- | | |
|---------------|----------------|
| i. CONSUMER | vi. PROVIDER |
| ii. CONSUMER | vii. PROVIDER |
| iii. CONSUMER | viii. CONSUMER |
| iv. PROVIDER | ix. CONSUMER |
| v. PROVIDER | x. PROVIDER |

- e) Briefly explain each of the following features of cloud computing.

- i. Scalability
- ii. Elasticity
- iii. Pay as you go

[2.0 × 3 = 6.0 marks]

Answers

- i. Scalability refers to the ability of a cloud system to handle increasing workloads by adding resources such as computing power, storage, or network capacity ❶. It can be vertical (scaling up/down) by upgrading existing resources or horizontal (scaling out/in) by adding more instances to distribute the load ❶.
- ii. Elasticity is the ability of a cloud system to automatically allocate and deallocate resources based on real-time demand ❶. This ensures optimal resource utilization by dynamically scaling resources up during peak loads and scaling down when demand decreases, improving cost efficiency ❶.
- iii. The pay-as-you-go model allows users to pay only for the cloud resources they consume rather than a fixed upfront cost ❶. This on-demand pricing model helps businesses reduce expenses by charging based on actual usage, such as storage, computing power, or bandwidth, rather than pre-purchasing resources ❶.

**** END OF THE QUESTION PAPER ****