CS222 — Operating Systems

Past Midterm Exams Study Pack

Qassim University | Department of Computer Science
Compiled from 4 past midterm papers: Sem 451, 461, 471, 462

How to use this pack

1. Start with the **"What Repeats Across Every Exam"** section — these are the highest-yield items for your midterm.

2. Work each sample exam **without** looking at the answer sheet. Try to answer everything on paper or mentally.

3. Flip to the answer sheet (next page after the sample) and check yourself. Mark every item you got wrong and review the concept before moving on.

4. Repeat until the repeated patterns feel automatic.

Good luck — ■■■■■■■■

What Repeats Across Every Exam

Across the four samples, the same concepts and even the same exact questions appear over and over. If you only have limited time, master these first.

Repeated MCQs (memorize these answers)

Question	Answer	Seen in
Scheduler that selects which process runs next & allocates CPU	Short-term scheduler	451, 461, 471, 462
NOT an advantage of multiprocessor systems	Reducing reliability	451, 461, 471, 462
Amount of time required to execute a particular process	Burst time*	461, 471, 462
Process that cannot affect or be affected by others	Independent process	451, 461, 462
Abstract hardware of a single computer into several execution environments	Virtual machine	451, 461, 462
Maintains information about a process	PCB	471, 462
Queue containing all processes in the system	Job Queue	451, 461
Time slice unit in Round Robin	Time Quantum	471

** **Watch out:** 471 answer key marks **Burst time**. Some students confuse this with Turnaround time. Burst time = the CPU time the process needs. Turnaround time = submission to completion. The wording "required to execute" = burst time.*

Repeated True/False (memorize the polarity)

Statement	Answer	Seen in
When time quantum increases, number of context switches increases	FALSE	451, 461, 471, 462
SJF scheduling gives MAXIMUM average waiting time	FALSE (it's minimum)	451, 461, 471, 462
CPU utilization means keeping the CPU as busy as possible	TRUE	451, 461, 471, 462
Protection is used to defense the system against internal & external attacks	FALSE (that's Security)	451, 461, 462
Main memory is the only large storage media the CPU can access directly	TRUE	461, 471, 462
A context switch occurs when CPU switches from one process to another	TRUE	462
Binary semaphore contains an integer value over an unrestricted domain	FALSE	451
MMU maps the virtual address generated by the CPU to its physical address	TRUE	451
DMA transfers data from buffer to memory without CPU intervention	TRUE	471
Context switching overhead does nothing useful	TRUE	471
Process is a passive entity, program is active entity	FALSE (it's the opposite)	461

Repeated Fill-in-the-Blank (memorize the keyword)

Sentence	Answer	Seen in
Peterson's solution is a solution to the ____ problem	critical section	451, 461, 471, 462
____ defense of the system against internal and external attacks	security	451, 461, 471, 462
The ____ scheduler selects which process runs next and allocates CPU	short-term	461, 471, 462
The one program running at all times on the computer is the ____	kernel	471, 462
A ____ process can affect or be affected by another process	cooperating	451, 461
Advantages of process cooperation: ____	info sharing / speed-up / modularity / convenience	462
System calls are mostly accessed via a high-level ____ rather than direct-call use	API	462
A program must be brought from disk into memory and placed within a ____ to run	process	451
A file system must be ____ before it can be accessed	mounted	451
Entity containing file system is known as a ____	volume	451
A device controller informs the CPU it finished its operation by causing an ____	interrupt	471
To track which users use how much resources, we use ____	accounting	471
____ is the activity of finding errors and fixing them in HW and SW	debugging	461
The ____ is used for high-speed I/O, transmits at near-memory speed	DMA	461

Repeated Short-Answer Questions

1. List the possible states for a process — appears in 451, 461, 462 (asks for 4, 3, and 2 states respectively).
Answer: **New, Ready, Running, Waiting, Terminated**.

2. In priority scheduling, low-priority processes may never execute. What is this problem called and what is the solution? — appears in 451, 461.
Answer: Problem = **Starvation**. Solution = **Aging** (gradually increase the priority of a process the longer it waits).

3. Compare Direct vs Indirect Communication — appears in 462.
4. Solution to Critical-Section Problem — appears in 471 (the 3 conditions) and 462 (asks for 2 actual solutions like Peterson's, Mutex, Semaphores).

Repeated Gantt Chart Question (almost word-for-word)

The **same Non-preemptive SJF table** appears in both 451 and 461:
P1 = 21, P2 = 3, P3 = 6, P4 = 2, all arrive at time 0.

Order: **P4** → **P2** → **P3** → **P1**
Gantt: |P4 (0–2)| P2 (2–5)| P3 (5–11)| P1 (11–32)|
Waiting times: P4=0, P2=2, P3=5, P1=11
Average waiting time = (0 + 2 + 5 + 11) / 4 = 18/4 = 4.5

Sample 471 swapped this for a **preemptive SJF** with arrival times. Sample 462 swapped it for a

Round Robin (q = 3): P1=6, P2=2, P3=4 → **avg waiting = 16/3** ≈ **5.33**. Be ready for any of the three: SJF non-preemptive, SJF preemptive, RR.

Essay-Style Topics That Have Appeared

• Solution to Critical-Section Problem — three requirements (Mutual Exclusion, Progress, Bounded Waiting). Seen in 471, 462.
• PCB (Process Control Block) — list 4 things it stores. Seen in 471.
• Why API is better than direct system calls — at least two reasons. Seen in 471, 462.
• Direct vs Indirect Communication — explain the difference. Seen in 462.
• Process State diagram — describe each state. Seen in 462.
• Advantages of process cooperation. Seen in 462.

Sample Exam 1 — Semester 451 (2023)

Dr. Sulaiman Al-Amro | Duration: 1 hour | 30 marks

Question 1 — MCQ (1 × 6 = 6 Marks)

Choose the correct (best match) answer:

1. The queue which contains a set of all processes in the system:

a) The Job Queue
b) The Ready Queue
c) The Waiting Queue
d) The Device Queue

2. The scheduler that selects which process should be executed next and allocates CPU is called:

a) Long-term scheduler
b) Medium-term scheduler
c) Short-term scheduler
d) High-term scheduler

3. If the CPU generated a logical address = 501 and the value of the relocation register = 1320, the physical address will be:

a) 2740
b) 1821
c) 902
d) 819

4. It is a process that cannot affect or be affected by other processes executing in the system:

a) A Cooperating process
b) An Independent process
c) A Passive process
d) A Terminated process

5. An abstract hardware of a single computer into several different execution environments:

a) Virtual machine
b) Live migration
c) Cloud computing
d) Network Address Translation (NAT)

6. Which of the following is NOT an advantage of multiprocessor systems:

a) Increasing throughput
b) Reducing reliability
c) Economy of scale
d) Fault tolerance

Question 2 — True / False (1 × 6 = 6 Marks)

1. Binary semaphore contains an integer value that can range over an unrestricted domain. [ ]

2. When the time quantum increases, the number of context switches increases. [ ]

3. The MMU maps the virtual address generated by the CPU to its physical address. [ ]

4. Protection is used to defense of the system against internal and external attacks. [ ]

5. SJF scheduling gives maximum average waiting time for a given set of processes. [ ]

6. CPU utilization means keeping the CPU as busy as possible. [ ]

Question 3 — Fill in the Blanks (1 × 6 = 6 Marks)

1. Entity containing file system is known as a _____ .

2. _____ defense of the system against internal and external attacks.

3. Peterson's Solution is a solution to the _____ problem.

4. A file system must be _____ before it can be accessed.

5. A _____ process can affect or be affected by the execution of another process.

6. A program must be brought from _____ into memory and placed within a process for it to be run.

Question 4 — Short Answer (3 + 3 = 6 Marks)

1. List four different possible states for a process.

2. In priority scheduling techniques low priority processes may never execute. What is this problem called and what is the solution to prevent such a problem?

Question 5 — Gantt Chart (6 Marks)

Consider the following table. Assume all processes arrived at time 0. Use the **Non Pre-emptive Shortest Job First** scheduling technique, draw the Gantt chart for the processes, and calculate the average waiting time.

Process	Duration (Burst Time)
P1	21
P2	3
P3	6
P4	2

Answer Sheet — Sample 1 (Semester 451)

Q1 — MCQ

1. a) The Job Queue

2. c) Short-term scheduler

3. b) 1821 *(501 + 1320 = 1821)*

4. b) An Independent process

5. a) Virtual machine

6. b) Reducing reliability

Q2 — True / False

1. FALSE — binary semaphore is 0 or 1 only (counting semaphore is unrestricted).

2. FALSE — larger quantum = fewer context switches.

3. TRUE — that is exactly the MMU's job.

4. FALSE — that defines **Security**, not Protection. (Protection = control access to resources.)

5. FALSE — SJF gives the **minimum** average waiting time.

6. TRUE — high CPU utilization is a primary scheduling goal.

Q3 — Fill in the Blanks

1. Volume

2. Security

3. Critical-section

4. Mounted

5. Cooperating

6. Disk

Q4 — Short Answer

1. Four process states (any 4 of the 5): **New, Ready, Running, Waiting, Terminated**.

2. Problem = **Starvation** (also called indefinite blocking). Solution = **Aging** — gradually increase a process's priority the longer it waits in the ready queue, so eventually it gets executed.

Q5 — Gantt Chart (Non-preemptive SJF)

Order shortest first: **P4 (2)** → **P2 (3)** → **P3 (6)** → **P1 (21)**

Gantt: **| P4 (0–2) | P2 (2–5) | P3 (5–11) | P1 (11–32) |**

Waiting times (start time – arrival, all arrived at 0):
P4 = 0, P2 = 2, P3 = 5, P1 = 11

Average waiting time = (0 + 2 + 5 + 11) / 4 = 18 / 4 = 4.5

Sample Exam 2 — Semester 461 (2024)

Choose the correct answer (1 × 6 = 6 Marks)

1. The queue which contains a set of all processes in the system:

a) The Job Queue
b) The Ready Queue
c) The Waiting Queue
d) The Device Queue

2. The scheduler that selects which process should be executed next and allocates CPU is called:

a) Long-term scheduler
b) Medium-term scheduler
c) Short-term scheduler
d) High-term scheduler

3. Amount of time required to execute a particular process:

a) Turnaround time
b) Waiting time
c) Response time
d) Burst time

4. It is a process that cannot affect or be affected by other processes executing in the system:

a) Cooperating process
b) An Independent process
c) A Passive process
d) A Terminated process

5. An abstract hardware of a single computer into several different execution environments:

a) Virtual machine
b) Live migration
c) Cloud computing
d) Network Address Translation

6. Which of the following is NOT an advantage of multiprocessor systems:

a) Increasing throughput
b) Reducing reliability
c) Economy of scale
d) Fault tolerance

Mark the below statements True or False (1 × 6 = 6 Marks)

1. Process is a passive entity, program is active entity. [ ]

2. When the time quantum increases, the number of context switches increases. [ ]

3. Main memory is the only large storage media that the CPU can access directly. [ ]

4. SJF scheduling gives maximum average waiting time for a given set of processes. [ ]

5. Protection is used to defense of the system against internal and external attacks. [ ]

6. CPU utilization means keeping the CPU as busy as possible. [ ]

Fill in the blank with the exact word or phrase (1 × 6 = 6 Marks)

1. _____ is the activity of finding errors and fixing them in both hardware and software.

2. _____ process can affect or be affected by the execution of another process.

3. Peterson's solution is a solution to the _____ problem.

4. _____ scheduler selects which process should be executed next and allocates CPU.

5. _____ defense of the system against internal and external attacks.

6. The _____ is used for high-speed I/O devices able to transmit information at close to memory speed.

Short Answer Questions

1. List three different possible states for a process. Give a description of each.

2. In priority scheduling techniques low priority processes may never execute. What is this problem called and what is the solution to prevent such a problem?

Gantt Chart Question

Consider the following table. Assume the processes arrived at time 0. Use the **Non pre-emptive Shortest Job First** scheduling technique, draw the Gantt chart for the processes, and calculate the average waiting time.

Process	Duration (Burst Time)
P1	21
P2	3
P3	6
P4	2

Answer Sheet — Sample 2 (Semester 461)

MCQ Answers

1. a) The Job Queue
2. c) Short-term scheduler
3. d) Burst time *(time required to execute = CPU burst time)*
4. b) An Independent process
5. a) Virtual machine
6. b) Reducing reliability

True / False Answers

1. FALSE — it's the opposite. **Program** is passive (a file on disk), **process** is active (program in execution).
2. FALSE — larger quantum = fewer context switches.
3. TRUE — only main memory & registers are CPU-directly-accessible.
4. FALSE — SJF gives the **minimum** average waiting time.
5. FALSE — that defines **Security**, not Protection.
6. TRUE.

Fill in the Blanks Answers

1. **Debugging**
2. **Cooperating**
3. **Critical-section**
4. **Short-term**
5. **Security**
6. **DMA (Direct Memory Access)**

Short Answer

1. **Three process states with description:**
   - **New** — the process is being created.
   - **Ready** — the process is waiting to be assigned to a processor.
   - **Running** — instructions are being executed.
   - **Waiting** — the process is waiting for some event to occur (e.g., I/O).
   - **Terminated** — the process has finished execution.

   (Pick any three.)
2. Problem = **Starvation**. Solution = **Aging**.

Gantt Chart (Non-preemptive SJF) — same table as 451

Order: **P4** → **P2** → **P3** → **P1**

Gantt: **| P4 (0–2) | P2 (2–5) | P3 (5–11) | P1 (11–32) |**

Waiting: P4 = 0, P2 = 2, P3 = 5, P1 = 11

Average waiting time = (0 + 2 + 5 + 11) / 4 = 4.5

Sample Exam 3 — Semester 471

Q1 — Multiple Choice (6 Marks)

1. The time required by the dispatcher to stop one process and start running another is called:

a) Context Switch
b) Dispatch Latency
c) Turnaround Time
d) Waiting Time

2. The component that selects from among the processes in the ready queue and allocates the CPU to one of them is:

a) Long-term scheduler
b) Medium-term scheduler
c) Short-term scheduler
d) I/O scheduler

3. Which of the following maintains information about a process?

a) CPU Register
b) Ready Queue
c) Process Control Block (PCB)
d) Scheduler

4. The amount of time required to execute a particular process is called:

a) Waiting Time
b) Response Time
c) Turnaround Time
d) Burst Time

5. In Round Robin (RR), each process gets a small unit of CPU time called:

a) Time Slice
b) Time Interval
c) Time Quantum
d) CPU Burst

6. Which of the following is NOT an advantage of multiprocessor systems?

a) Increased throughput
b) Economical
c) Reducing reliability
d) Faster processing

Q2 — True / False (6 Marks)

1. DMA transfers data from the buffer to memory without CPU intervention. [ ]

2. Context switching overhead does nothing useful. [ ]

3. The main memory is the only large storage media that the CPU can access directly. [ ]

4. SJF scheduling gives maximum average waiting time for a given set of processes. [ ]

5. CPU utilization means keeping the CPU as busy as possible. [ ]

6. When the time quantum increases, the number of context switches increases. [ ]

Fill in the Blanks (6 Marks)

1. The one program running at all times on the computer is called the _____ .

2. To keep track of which users use how much and what kinds of computer resources, we use _____ .

3. A device controller informs the CPU that it has finished its operation by causing an _____ .

4. Peterson's Solution is a solution to the _____ problem.

5. The component that selects from among the processes in the ready queue and allocates the CPU to one of them is the _____ .

6. Defense of the system against internal and external attacks is called _____ .

Essay Questions (6 Marks)

1. Solution to the Critical-Section Problem — give the requirements/conditions with explanation.

2. Process Control Block (PCB) — list 4 pieces of information stored in it.

3. Why is API better than direct system calls? Give two reasons.

Q5 — Gantt Chart: SJF (Pre-emptive) (6 Marks)

Use the Pre-emptive Shortest Job First scheduling technique.

Process	Arrival	Burst
P1	0	8
P2	4	10
P3	4	3
P4	10	4

Answer Sheet — Sample 3 (Semester 471)

MCQ Answers

1. A) Context Switch
2. C) Short-term scheduler
3. C) Process Control Block (PCB)
4. D) Burst Time
5. C) Time Quantum
6. C) Reducing reliability

True / False Answers

1. TRUE — that is the whole purpose of DMA.
2. TRUE — context switches are pure overhead, no useful work happens.
3. TRUE.
4. FALSE — SJF gives the **minimum** average waiting time.
5. TRUE.
6. FALSE — larger quantum = **fewer** context switches.

Fill in the Blanks Answers

1. **Kernel**
2. **Accounting**
3. **Interrupt**
4. **Critical-section**
5. **Short-term scheduler**
6. **Security**

Essay Answers

1. **Solution to Critical-Section Problem** — must satisfy three conditions:
   • **Mutual Exclusion** — if process P_i is executing in its critical section, then no other processes can be executing in their critical sections.
   • **Progress** — if no process is executing in its critical section and some processes wish to enter, the selection of which one enters next cannot be postponed indefinitely.
   • **Bounded Waiting** — there is a bound on the number of times other processes can enter their critical sections after a process has requested entry and before that request is granted.

2. **PCB stores (any 4):** process state, program counter, CPU registers, CPU scheduling info (priority, queue pointers), memory management info (base/limit registers, page tables), accounting info (CPU used, time limits), I/O status info (open files, allocated devices), process number / PID.

3. Why API is better than direct system calls (any 2):

- **Portability** — code written against an API can run on any system that supports that API, even if the underlying system calls differ.
- **Simplicity / abstraction** — APIs hide the complex details of system calls behind clean function calls; the programmer doesn't need to know register conventions, trap numbers, etc.
- **Safety** — the API can validate inputs and handle errors before invoking the kernel.

Q5 — SJF Preemptive

P1 starts at 0. At t=4, P2 (burst 10) and P3 (burst 3) arrive. P1 has 4 left → P3 has the shortest remaining → preempt and run P3.

- t = 0–4: **P1** runs (4 of 8 done, 4 left)
- t = 4–7: **P3** runs to completion (3 done)
- t = 7–11: **P1** finishes its remaining 4 (P4 arrives at t=10 with burst 4; P1 still has 1 left at t=10, so P1 keeps running until t=11)
- t = 11–15: **P4** runs (burst 4)
- t = 15–25: **P2** runs (burst 10)

Gantt: **| P1 (0–4) | P3 (4–7) | P1 (7–11) | P4 (11–15) | P2 (15–25) |**

Waiting times (turnaround – burst, where turnaround = completion – arrival):

P1: 11 – 0 – 8 = **3**
P2: 25 – 4 – 10 = **11**
P3: 7 – 4 – 3 = **0**
P4: 15 – 10 – 4 = **1**

Average waiting time = (3 + 11 + 0 + 1) / 4 = 15/4 = 3.75

Sample Exam 4 — Semester 462

Question 1 — Multiple Choice (6 Marks)

1. Which of the following maintains information about a process?

a) Stack
b) Translation Lookaside Buffer
c) Process Control Block
d) Program Control Block

2. The scheduler that selects which process should be executed next and allocates CPU is called:

a) Long-term scheduler
b) Medium-term scheduler
c) Short-term scheduler
d) High-term scheduler

3. The amount of time which is required to execute a particular process is called:

a) Waiting time
b) Burst time
c) Response time
d) Turnaround time

4. Which of the following is NOT an advantage of multiprocessor systems?

a) Increasing throughput
b) Increasing reliability
c) Faster execution of processes
d) Reducing reliability

5. A process that cannot affect or be affected by other processes executing in the system is called:

a) A Cooperating process
b) An Independent process
c) A Passive process
d) A Terminated process

6. An abstract hardware of a single computer into several different execution environments is called:

a) Virtual machine
b) CPU scheduling
c) Cloud computing
d) Network Address Translation (NAT)

Question 2 — True or False (6 Marks)

1. When the time quantum increases, the number of context switches increases. [ ]

2. The main memory is the only large storage media that the CPU can access directly. [ ]

3. A context switch occurs when the CPU switches from executing one process to another. [ ]

4. Protection is used to defend the system against internal and external attacks. [ ]

5. SJF scheduling gives maximum average waiting time for a given set of processes. [ ]

6. CPU utilization means keeping the CPU as busy as possible. [ ]

Question 3 — Fill in the Blanks (6 Marks)

1. _____ is the one program running all the time on the computer.

2. _____ is the defense of the system against internal and external attacks.

3. _____ are mostly accessed by programs via a high-level _____ rather than direct-call usage.

4. _____ scheduler selects which process should be executed next and allocates CPU.

5. Peterson's Solution is a solution to the _____ problem.

6. Advantages of process cooperation: _____ .

Question 4 — Short Answer (2 + 2 + 2 = 6 Marks)

1. List and explain two different states a process can be within an operating system.

2. Describe two general solutions to the Critical-Section Problem and explain how each works.

3. Compare between Indirect Communication and Direct Communication.

Question 5 — Gantt Chart: Round Robin, q = 3 (6 Marks)

Assume all processes arrived at time 0. Use the **Round Robin (RR)** scheduling technique with **q = 3**, draw the Gantt Chart, and calculate the average waiting time.

Process	Duration (Burst Time)
P1	6
P2	2
P3	4

Answer Sheet — Sample 4 (Semester 462)

Q1 — MCQ

1. c) Process Control Block

2. c) Short-term scheduler

3. b) Burst time

4. d) Reducing reliability *(note: option (b) "Increasing reliability" IS an advantage — the trick is option (d))*

5. b) An Independent process

6. a) Virtual machine

Q2 — True / False

1. FALSE — larger quantum means **fewer** context switches.

2. TRUE — only main memory and registers are CPU-directly-accessible.

3. TRUE — that is the textbook definition of a context switch.

4. FALSE — that defines **Security**, not Protection.

5. FALSE — SJF gives the **minimum** average waiting time.

6. TRUE.

Q3 — Fill in the Blanks

1. Kernel

2. Security

3. System calls are mostly accessed by programs via a high-level **API (Application Program Interface)** rather than direct-call usage.

4. Short-term scheduler

5. Critical-section problem

6. Information sharing, Computation speed-up, Modularity, Convenience (any one or more)

Q4 — Short Answer

1. Two process states with explanation (pick any two):

- **Ready** — the process has everything it needs and is waiting to be assigned to a CPU/processor.
- **Running** — the process is currently being executed; its instructions are running on the CPU.
- **Waiting** — the process is blocked, waiting for some event such as I/O completion or a signal.
- **New** — the process is being created.
- **Terminated** — the process has finished execution and is being removed from the system.

2. Two general solutions to the Critical-Section Problem (pick any two):

• **Peterson's Solution (software):** A classic two-process solution using two shared variables — *turn* (whose turn it is) and *flag[2]* (which process wants in). A process sets its own flag = true, sets turn to the other process, then waits while the other process's flag is true AND turn belongs to the other. This guarantees mutual exclusion, progress, and bounded waiting on systems with proper memory ordering.

• **Synchronization Hardware (TestAndSet / Swap):** Special atomic CPU instructions that test and modify a memory location in one uninterruptible step. A process loops on TestAndSet(lock) until it returns false (lock free), then enters the critical section and sets lock = false on exit. Hardware atomicity prevents race conditions.

• **Mutex Locks:** A higher-level abstraction with two operations — *acquire()* and *release()*. A process must acquire the lock before entering its critical section and release it on exit. While the lock is held, other processes calling acquire() are blocked.

• **Semaphores:** An integer variable accessed only through two atomic operations — *wait()* (decrement; block if value < 0) and *signal()* (increment; wake one waiting process). A binary semaphore initialized to 1 acts as a mutex; a counting semaphore manages a pool of N identical resources.

3. Indirect vs Direct Communication:

• **Direct Communication:** processes must **name each other explicitly**. Each send/receive specifies the exact partner process. The link is established automatically between exactly one pair of processes, and it's unique to that pair.

• **Indirect Communication:** messages are sent to and received from **mailboxes (or ports)**. The sender doesn't need to know the receiver's identity — it just posts to a mailbox. A link can be associated with many processes, and a single pair of processes can share several links via multiple mailboxes.

Q5 — Round Robin (q = 3) Gantt Chart

Initial ready queue (all arrive at t = 0): [P1, P2, P3]

• t = 0–3: **P1** runs full quantum (P1 remaining = 3). Queue → [P2, P3, P1]
• t = 3–5: **P2** runs to completion (only needed 2). Queue → [P3, P1]
• t = 5–8: **P3** runs full quantum (P3 remaining = 1). Queue → [P1, P3]
• t = 8–11: **P1** runs to completion (P1 remaining = 0). Queue → [P3]
• t = 11–12: **P3** runs to completion.

Gantt: **| P1 (0–3) | P2 (3–5) | P3 (5–8) | P1 (8–11) | P3 (11–12) |**

Waiting time = turnaround – burst (turnaround = completion – arrival; arrival = 0 for all):
P1: 11 – 6 = **5**
P2: 5 – 2 = **3**
P3: 12 – 4 = **8**

Average waiting time = (5 + 3 + 8) / 3 = 16 / 3 ≈ 5.33

Final Notes — High-Yield Patterns

After working through all four samples, here are the patterns that hit hardest:

1. Three T/F questions appeared in ALL FOUR exams:
- Time quantum vs. context switches → **inverse** relationship (FALSE).
- SJF gives **minimum** average waiting time, not maximum (FALSE).
- CPU utilization = keeping CPU as busy as possible (TRUE).

2. Two MCQs appeared in ALL FOUR exams:
- **Short-term scheduler** selects from ready queue and allocates CPU.
- **Reducing reliability** is the wrong (NOT-an-advantage) option for multiprocessor systems.

3. Two fill-in keywords appeared in ALL FOUR exams:
- **Critical-section** (Peterson's solution).
- **Security** (defense against attacks — NOT Protection).

4. The Protection vs Security trap appears constantly — defense against attacks = **Security**. Protection = controlling access of processes/users to system resources. If the question says "defense against attacks" and the word "Protection" appears, it's FALSE.

5. Three concepts you must memorize cold:
- **Starvation → Aging**
- **Peterson's solution → Critical-section problem**
- **5 process states**: New, Ready, Running, Waiting, Terminated

6. Gantt chart variants: 451 and 461 had the same Non-preemptive SJF (avg = 4.5). 471 had Preemptive SJF (avg = 3.75). 462 had Round Robin q=3 (avg ≈ 5.33). Practice all three techniques — your exam will be one of them.

7. Critical-section question has two flavors: 471 asked for the 3 **requirements** (Mutual Exclusion, Progress, Bounded Waiting). 462 asked for 2 actual **solutions** (Peterson's, hardware atomic instructions, mutex locks, semaphores). Read the question carefully.

End of study pack. ■■■■■■■■ ■■ ■■■■.