Exercise walk-through

Purposes of an Operating System (OS) ▪ 16.1

eXercise

You must be able to

- explain how an OS **maximises use of resources**
- describe **process management** (states, scheduling, context switch)
- explain **virtual memory**, **paging** and **segmentation**

Method — Managing resources

The OS shares the CPU, memory and devices fairly: **multi-tasking** (switch the CPU between processes), **memory management**, **spooling**/buffering (print jobs queue on disk), and **caching**.

Method — Process management

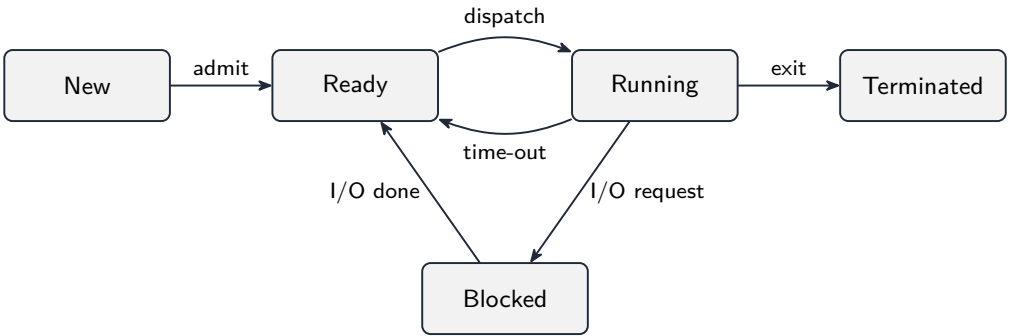
A **process** is a program in execution. The **scheduler** picks which ready process runs next. Common routines:

- **First Come First Served (FCFS)** — run in arrival order (simple, but a long job delays the rest).
- **Shortest Job First (SJF)** — run the job with the shortest expected time next (low average wait).
- **Shortest Remaining Time (SRT)** — pre-emptive SJF: switch to a newly-arrived shorter job.
- **Round robin** — each process gets a fixed **time slice** in turn, then goes to the back of the queue (fair, responsive).

Method — Process management

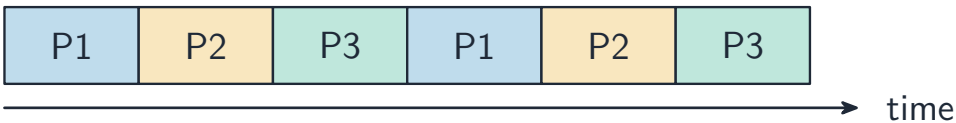
A process moves between states:
Switching from one process to another saves/restores state via the **process control block** (PCB) — a **context switch**. An **interrupt** makes the CPU pause the current process; the OS **kernel** runs the matching interrupt service routine (for an I/O-complete signal, a timer, or an error), then resumes — this is how the OS responds to events.

Method — Process management



Method — Process management

each process gets a fixed time slice, then the next one runs



Round-robin scheduling shares the processor fairly

Method — Virtual memory

Each process gets its own **virtual address space**, mapped to physical RAM. In **paging**, virtual memory is split into fixed **pages**, RAM into **frames**, linked by a **page table**. A **page fault** (page not in RAM) loads it from the **swap file**, evicting another page. This lets total memory **exceed RAM**; too many faults cause **thrashing**. **Segmentation** uses variable-sized logical segments (code, stack, heap).

Practice 2.1 ▪ 1 mark

State **two** resources that an operating system manages.

Solution 2.1

Worked steps

Any two of: CPU (time), memory/RAM, disk/storage, I/O devices B1 *for two.*

Practice 2.2 ▪ 1 mark

State what **round-robin** scheduling does.

Solution 2.2

Method: Process management

Worked steps

Gives each process a **fixed time slice** of CPU in turn, then moves it to the **back of the queue** B1.

Practice 2.3 ▪ 2 marks

Name the **five** process states.

Solution 2.3

Method: Process management

Worked steps

New, Ready, Running, Blocked, Terminated B1 B1 *for three, for all five.*

Practice 2.4 ▪ 1 mark

State what a **context switch** is.

Solution 2.4

Method: Process management

Worked steps

Saving the state of one process (to its PCB) and **restoring** another's, so the CPU can switch between them B1.

Exam-style 3.1 ▪ 4 marks

Draw the **process state diagram** with the states New, Ready, Running, Blocked and Terminated, and label the transitions.

Solution 3.1

Method: Process management

Worked steps

Correct states and transitions: New→Ready (admit) B1; Ready Running (dispatch / time-out) B1; Running→Blocked (I/O request) and Blocked→Ready (I/O done) B1; Running→Terminated (exit) B1.

Exam-style 3.2 ▪ 2 marks

Explain what happens to a **running** process when it requests **input/output**.

Solution 3.2

Method: Process management

Worked steps

The process moves from **Running** to **Blocked** B1; the scheduler then **dispatches another ready process** to the CPU while it waits B1.

Exam-style 3.3 ▪ 3 marks

Explain how **virtual memory** lets programs use more memory than the physical RAM.

Solution 3.3

Method: Virtual memory

Worked steps

Each process has a **virtual address space** split into **pages** B1; only the pages in use are kept in RAM **frames**, the rest stay in the **swap file** on disk B1; on a **page fault** the OS swaps a page in (evicting one if needed), so the program can be larger than physical RAM B1.

Exam-style 3.4 ▪ 1 mark

State what causes **thrashing**.

Solution 3.4

Worked steps

Too little RAM for the active pages, so the OS spends most of its time **swapping pages in and out** instead of doing useful work B1.

Exam-style 3.5 ▪ 2 marks

Describe the **Shortest Job First (SJF)** scheduling routine and give **one** benefit of it.

Solution 3.5

Method: Process management

Worked steps

SJF runs the ready process with the **shortest expected run time** next B1; benefit: the **lowest average waiting time** — short jobs are not stuck behind long ones B1.