Study Guide: Understanding File Systems

1. What Is a File System?

A **file system** is a technology that defines how data is **stored**, **organized**, and **retrieved** from storage devices like hard drives and SSDs. The **operating system** uses the file system to interpret raw binary data and present it as usable **files and folders**.

Folders (Directories):

- Organize files hierarchically (folders within folders).
- Allow logical structuring of digital content.

Files:

- Contain data (text, video, code, etc.).
- Identified by **names** and **extensions** (e.g., `.docx`, `.py`, `.pdf`).

File Name & Extensions:

- File **name**: User-defined.
- File **extension**: Tells the OS how to open the file.

Example	Extension	Description
Word Document	.docx	Opened by Microsoft Word
Excel Spreadsheet	.xlsx	Microsoft Excel
Java Archive	.jar	Java-based applications
Python File	.py	Python script
Executable	.exe	Windows application
Android App	.apk	Android package

Unix/Linux/MacOS use file attributes instead of extensions to define executability.

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3. Core File System Features

Feature	Description
Permissions	Control who can read, write, execute, or delete files. Key to cybersecurity.
Compression	Reduces file size by eliminating redundancy. e.g., `.zip` archives.
Encryption	Protects file content from unauthorized access using cryptography.
Journaling	Keeps a log of file changes to recover from crashes or power failures.

4. Common File System Types

File System	OS	Features	Notes
NTFS	Windows	✔ Compression ✔ Encryption ✔ Journaling	Native to Windows; read-only on Mac/Linux without tools.
FAT32	Universal	✘ Encryption ✘ Journaling ✘ Compression	Limited to 4GB files; useful for USB drives.
exFAT	Cross-platform	✘ Journaling ✘ Encryption ✘ Compression	Successor to FAT32, handles larger files.
EXT4	Linux	✔ Encryption ✔ Compression ✔ Journaling	Supports up to 16TB files.
HFS+	Mac (legacy)	✔ Compression ✔ Encryption ✔ Journaling	Older Apple FS, succeeded by APFS.
APFS	macOS (modern)	✔ Encryption ✘ Native Compression Crash-protection	Optimized for SSDs; released in 2017.

5. File Management Concepts

Operating System Responsibilities:

- Track where files are located on disk.
- Manage extensions and permissions.
- Handle read/write access, execution rights, and deletion.

Reserved Characters (Avoid in filenames):

/, \, *, <, >, ", |, :

Avoid these to ensure cross-platform compatibility and prevent errors.

6. Visualizing File Systems: Example from macOS

As shown in your screenshot, a **multi-column hierarchical view** allows users to:

- Drill into directories.
- View file details (type, size, permissions).
- Navigate folder paths intuitively.

At the bottom: **Sharing & Permissions** section reveals:

- Users & groups who have access.
- Read/write/execute rights.

7. Summary Table for Exam Review

Concepts & Descriptions

File System = Method OS uses to store and organize files.

File = Named collection of data (text, media, code).

Folder (Directory) = Container used to organize files hierarchically.

Permission = Rules controlling access to a file/folder.

Compression = Reduces disk usage by making files smaller.

Encryption = Secures data so only authorized users can read it.

Journaling = Prevents data loss during interruptions.

File Extension = Identifies file type and associated application.