Operating Systems

Tutorial Worksheet 01

Description. This tutorial worksheet covers an introduction to operating systems and computer system architecture. It it is just an overview, hence does not go deep in technical details.

Exercise 1 (Operating Systems)

1. **Understanding Fundamental Concepts**

(a) What is a system?

(b) Give a sound and complete definition of an operating system.

(c) What are the different modules of an operating system?

(d) In software engineering, there are two types of software systems: system software, and application software. What is the difference between the two?

(e) How would you classify an operating system (system Vs application software)? Explain.

(f) Choose three concrete types of operating systems and compare them w.r.t., reliability, UX, UI, performance, security, maintenability, accessibility to source code, license, ...

(g) Recall the process of booting up an operating system.

(h) What happens when you power on a computer on which you have multiple operating systems installed on the same disk (e.g., Ubuntu, Windows 11, and Parrot OS)?

(i) What is BIOS and UEFI? Are they system or application software?

2. **Types of Operating Systems**

(a) Discuss the concept of multiprogramming, single-tasking, multi-tasking, multi-processing, and multi-threading?

(b) Discuss the concept of time-sharing systems?

(c) Relate the above concepts to the operating system you use everyday?

(d) Complete the following table:

Operating System	Example (2/2)	Brief Description
Desktop OS	...	...
Real-time OS	...	...
Embedded OS	...	...
Mobile OS	...	...
Distributed OS	...	...
Network OS	...	...
Virtualization OS	...	...
Clustered OS	...	...

(e) Which type of operating system is used in the following computers: a laptop, a web-servers, a smartphones, an ATM (Automated teller machine), a self-driving car, a jet-fighter, an Unmanned Aerial Vehicles (e.g., drones), and a company's resource management server?

Exercise 2 (Computer Architecture)

1. **Von Neumann Architecture (VNA)**

(a) What are the main components of a computer according to the VNA?

(b) Discuss the system used by the above components to communicate?

(c) Use a diagram to illustrate the different components and how they are connected. You can abstract the inner structure of the components.

(d) Another architectural model, known as the Harvard architecture (HA), exists. What is the key difference compared to VNA? Which one became the De facto model for computers?

2. **CPU and Memory Dependence**

(a) Compute the following values (in multiples of bytes): 2^{11}, 2^{20}, 2^{23}, 2^{29}, 2^{37}, 2^{46}, and 2^{55}.

(b) Consider a central memory (RAM — Random Access Memory) that can store 1 byte per physical location (i.e., row). Each location is identified by an address. Each address is expressed in 8 bits. What is the size of this memory in bytes (1 byte encodes 8 bits)?

(c) Consider a computer with a 32-bit CPU (Central Processing Unit) — that is, it can process 32 bits at a time. The CPU is connected to a byte-addressable cenrtal memory (RAM). In theory, how much memory can be addressed in this computer (in multiples of bytes)?

(d) Now consider a computer with a 16-bit CPU (Central Processing Unit), which is connected to a word-addressable memory (RAM — Random Access Memory). In theory, how much memory can be addressed in this computer?