Syrian Arab Republic

Higher Institute for Applied Sciences and Technology

Course Specification Document

Title	Real Time Operating Systems

Credits	4 ECTS

Aims	This course aims to explain the basic concepts and principles of computer operating systems and to create a clear understanding for the student about their structure and internal working mechanism, enabling him to develop applications that make optimal use of these systems. The course also aims to introduce the student to real-time systems concepts and their design issues, scheduling real-time tasks in a traditional single-processor computer system, and some advanced issues such as resource sharing and task dependencies in scheduling, and operating systems that support real-time tasks, making the student qualified to analyze and design various real-time systems with diverse applications and purposes.

Intended learning outcomes

On successful completion of this course, the student will be able to:

- Understand how a computer system works and its main components.
- Understand the main operating system components and their functions.
- Understand the difference between processes and threads.
- Comprehend operating system structures and and recognize virtual machines.
- Understand the principles of inter-processes communication and synchronization.
- Understand the principles of scheduling in an operating system and identify some of its algorithms.
- Understand the concepts of real-time systems.
- Understand and and recognize the modeling of time constraints in a real-time system.
- Comprehend real-time scheduling algorithms with or without resource sharing and dependencies between tasks.
- Understand the real-time requirements of operating systems and realizing the degree of compatibility of traditional operating systems with these requirements.
- Create simple shell scripts.
- Program inter-processes communication.
- Program threads.
- Execute simple programs on a Linux operating system loaded on an external card.

Syllabus

- **Introduction:** A brief history of computers and the operating systems, types of operating systems and their characteristics.
- **Computer system architecture:** General computer architecture and how the CPU works, interrupts, input/output structure, storage structure, hardware protection.

- **Operating system structure:** Operating system components, system calls, system programs, system software structure, system design, implementation and generation, virtual machines.
- **Processes and threads**: Process concept, process creation, cloning and termination, threads and their management, comparison between threads and processes.
- **CPU scheduling:** Scheduling concepts, scheduling criteria, main scheduling algorithms.
- **Communication and synchronization in the operating system**: Inter-processes communication (communication using shared memory, communication using the messaging system), inter-processes synchronization (the race condition, critical section, mutual exclusion, deadlocks).
- **Memory management:** Multistep processing of a program, addresses binding, logical and physical addresses, swapping, memory allocation (contiguous allocation, paging, virtual memory).
- **Introduction to real-time systems:** Definition of the real-time system and introducing some applications of real-time systems, model of the real-time system, characteristics of real-time systems, reliability and safety of real-time systems, types of tasks in real-time systems, definition and modeling of time constraints.
- **Scheduling of real-time tasks:** Important concepts of scheduling, characteristics of real-time tasks, types of schedulers, clock-driven scheduling and its types, event-driven scheduling, scheduling based on the F-B algorithm, EDF scheduling RMA scheduling, DMA scheduling.
- **Introducing resource sharing and dependencies between tasks in scheduling:** Some important concepts, the principle of priority inversion and the issue of unbounded priority inversion, the PIP algorithm and its problems, the HLP algorithm and its drawbacks, the PCP algorithm, the different types of priority inversion under PCP, features of the PCP algorithm, a comparison between PIP,HLP, and PCP algorithms, handling the issue of dependencies between tasks.
- **Real-time operating systems:** Time services, clock interrupt handling, features of real-time operating systems, features of UNIX systems that support real-time, real-time operating systems based on UNIX, POSIX standard for real-time operating systems.
- **Practical sessions:**
  - Installation and configuration of Linux operating system on an external card and on virtual machine.
  - Learning shell command and how to create simple shell scripts.
  - Programming inter-process communication.
  - Programming threads.
  - Executing small programs on Linux operating system.