Operating Systems

1. **Course number and name**: 020SSEES4/020OPSES4 Operating Systems

2. **Credits and contact hours**: 4 ECTS credits, 2x1:15 contact hours (course + lab)

3. **Name of course coordinator**: Maroun Chamoun

4. **Instructional materials**: Handouts posted on the Web

   References:
   - **A. Tanenbaum**, Systèmes d'exploitation, 3ème édition, Pearson.
   - **W. Stallings**, Operating Systems – Internals and Design Principles, seventh edition, Prentice Hall.

5. **Specific course information**
   a. **Catalog description**:
      Introduction to operating systems - Operating system structures, computer hardware properties - Process concept in modern operating systems - Multi-processes - Thread concept and multi-threading - Process synchronization - Process synchronization - Deadlocks in multi-processing - Memory management - Virtual memory management - CPU scheduling algorithms - File system - Disk subsystem - Security.

   b. **Prerequisites*:*** None

   c. **Required** for CCE Software Engineering Option students; **Selected Elective** for students in the CCE Artificial Intelligence and Telecommunication Networks Options.

6. **Educational objectives for the course**
   The goal of this course is to provide an introduction to the internal operation of modern operating systems. In particular, the course will cover processes and threads, mutual exclusion, CPU scheduling, deadlock, memory management, and file systems.

   a. **Specific outcomes of instruction**
      - Learn the principles operating systems.
      - Understand relationship between subsystems of a modern operating system.
      - Demonstrate the operation of well-known theoretical algorithms with respect to deadlock, process and disk scheduling, and memory management.
      - Become familiar with multithreaded programming in C using POSIX pThreads on Unix.
      - Design algorithms to provide concurrent access to shared resources.
      - Develop multi-process and multi-threaded applications.

- Evaluate the efficiency aspect of using system resources (processor, memory, disk).
- Illustrate the separation of policy and mechanism with examples from operating system design and implementation.

b. PI addressed by the course:

PI	1.1	1.2	1.3
Covered	x	x	x
Assessed	x	x	x

7. Topics and approximate lecture hours

- Introduction: Overview of operating systems, functionalities and characteristics of OS Hardware concepts related to OS History of Operating Systems (2 Lectures)
- Operating systems Structure: operating system organization, operating system components, operating system Types (1 Lecture)
- Processes: The concept of a process, operations on processes, process states, process control block, process context, UNIX process control and management, forks, Interrupt processing, Interprocess Communication (IPC), Message Passing, Direct and Indirect (3 Lectures)
- Threads: Thread concept, Thread types, Thread models, multi-threading programming, POSIX thread (3 Lectures)
- Scheduling: Job and processor scheduling, scheduling algorithms, process hierarchies, Thread attributes (2 Lectures)
- Process Synchronization: Concurrent processes, Problems of concurrent processes, critical sections, mutual exclusion, synchronization, deadlock, Mutual exclusion, process co-operation, producer and consumer processes, Semaphores: definition, init, wait, signal operations, implementation of semaphores, Critical regions, Conditional Critical Regions, Monitors (6 Lectures)
- Homework: Implement Process synchronization model (12 hours of mini-project)
- Deadlock: prevention, detection, avoidance, banker's algorithm (2 Lectures)
- Memory and virtual memory: Memory organization and management, storage allocation Virtual memory concepts, paging and segmentation, address mapping, Virtual storage management, page replacement strategies (3 Lectures)
- Files: File organization: blocking and buffering, file descriptor, File and Directory structures, blocks and fragments, directory tree, inodes, file descriptors, UNIX file structure (3 Lectures)
- Secondary Storage: Organizing the I/O function, disk architectures, Secondary Storage Management, disk components, disk scheduling, RAID, disk caching, swap-space management (2 Lectures)
- Security: Protection and Security, access rights, access matrix (2 Lectures)