OPERATING SYSTEM
ENCT 254

Lecture : 3
Tutorial : 1
Practical : 3/2

Year
Part :

Course Objectives:
The objective of this course is to familiarize students with the different aspects of operating systems and encourage them to use these ideas in designing operating systems.

1 Introduction (6 hours)

1.1 Introduction to operating systems
1.2 OS as an extended machine and resource manager
1.3 History of operating system
1.4 Type of operating system: Mainframe, server, personal, smartphone and handheld, IOT and embedded, real-time, smart-card
1.5 Operating system components: Kernel, shell, utilities, applications
1.6 Types of OS kernel: Monolithic, micro, nano, layered, hybrid, exo-kernel
1.7 System calls, shell commands, shell programming
1.8 POSIX standard
1.9 Bootloader, MBR/GPT, UEFI and legacy boot
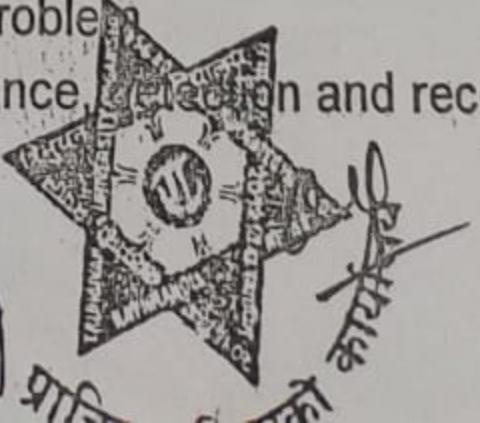
2 Process Management (7 hours)

2.1 Process description, states and control
2.2 Scheduling algorithms
    2.2.1 First Come First Serve (FCFS)
    2.2.2 Shortest Job First (SJF)
    2.2.3 Shortest Remaining Time(SRT)
    2.2.4 Round Robin (RR)
    2.2.5 Highest Response Ratio Next (HRNN)
    2.2.6 Completely Fair Scheduler (CFS) used in Linux
2.3 Threads and thread scheduling

3 Process Communication and Synchronization (10 hours)

3.1 Principles of concurrency, race condition, critical region
3.2 Mutual exclusion, semaphores, and mutex
3.3 Message passing and monitors
3.4 Classical problems of synchronization: Readers-writers problem, producer-consumer problem, dining philosopher problem
3.5 Deadlock: Prevention, ignorance, avoidance, detection and recovery

4 I/O and Memory Management (9 hours)

4.1 I/O management
  4.1.1 Principles of I/O hardware and software
  4.1.2 I/O software layer
  4.1.3 Disk technologies: Magnetic disk, SSD, NVMe storage
  4.1.4 RAID
  4.1.5 Concept of stable storage, cost per bit comparison

4.2 Memory Management
  4.2.1 Memory address, swapping and managing free memory space
  4.2.2 Virtual memory management, paging, segmentation
  4.2.3 Page replacement algorithms (FIFO, LRU, LFU), page fault and hit ratio
  4.2.4 Allocation of frames
  4.2.5 Thrashing

5 File Systems (3 hours)

5.1 File concepts: Name, structure, types, access, attributes, operations
5.2 Directory structures: Paths and hierarchies (Linux/Windows)
5.3 File system implementation: Inodes, allocation methods (Contiguous, linked, indexed)
5.4 File system performance: Factors affecting efficiency
5.5 Example file systems: NTFS, EXT4, FAT32, NFS

6 Security and System Administration (3 hours)

6.1 OS security: Cryptography, multi-factor authentication (MFA), secure boot and sandboxing
6.2 Access control: Policies, lists, and OS support
6.3 System administration: User management, environment setup and tools (AWK, shell scripts, make)

7 Hypervisors and Virtual Systems (4 hours)

7.1 Hypervisors: Type 1 and type 2
7.2 Virtual machines: Creating virtual machine in Qemu/Virtual box/VMWare
7.3 Container virtualization: Docker and Kubernetes
7.4 Power shell and windows subsystem for LINUX (WSL)
7.5 Performance optimization and security in virtualized environments

8 Overview of Contemporary OS (3 hours)
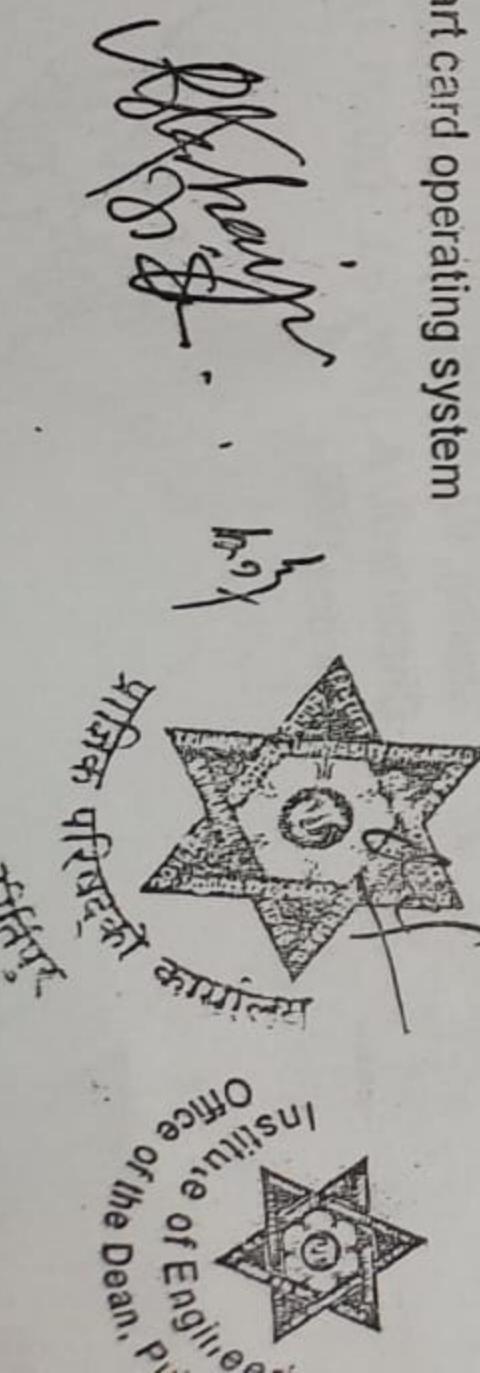
8.1 Windows and Linux-based OS
8.2 Embedded and mobile OS
8.3 IoT and RT operating system
8.4 Robot and smart card operating system

Tutorial

1. Unix shell programs to do a variety of tasks
2. Problems on scheduling algorithms
3. Problems on page replacement algorithms
4. Problems on deadlock
5. Problems on segmentation and paging
6. Comprehensive study on storage technologies with cost/bit and speed comparisons
7. Study on process management/memory management/IO management security/file system of a selected OS

(22.5 hours)

Practical

1. Basic Unix commands
2. Shell Programming
3. Implementation of the ls and grep commands
4. Programs using the I/O system calls of the UNIX operating system
5. Implementation of scheduling algorithms and the producer-consumer problem using semaphores
6. Implementation of some memory management schemes such as paging and segmentation
7. Term Project

Final Exam

The questions will cover all the chapters in the syllabus. The evaluation scheme will be as indicated in the table below:

Chapter	Hours	Marks Distribution*
1	6	8
2	7	10
3	10	13
4	9	12
5	3	4
6	3	4
7	4	5
8	3	4
Total	45	60

* There may be minor deviation in marks distribution.

Reference

1. Tanenbaum, A.S., Bos, H. (2024). Modern Operating Systems .3rd Edition. PHI.
2. Stalling, W. (2008). Operating Systems. 6th Edition. Pearson Education.
3. Chaturvedi, A., Rai, B.L. (2017). UNIX and Shell Programming. University Science Press.