Course Title: Operating Systems **Credit: 3**
Course No: CSIT.215 **Number of period per week: 3+3**
Nature of the Course: Theory + Lab **Total hours: 45+45**
Year: Second, Semester: Third
Level: B. Sc. CSIT

1. Course Introduction

This course demonstrates basic features of operating system components. It describes process management, deadlocks and process synchronization, memory management techniques, File system implementation, and I/O device management principles. It also includes case study on Linux operating system so that students can compare principles studied in the course with their real implementation.

2. Objectives

At the end of this course the students should be able to:

- Describe need and role of operating system.
- Understood OS components such a scheduler, memory manager, file system handlers and I/O device managers.
- Analyze and criticize techniques used in OS components
- Demonstrate and simulate algorithms used in OS components
- Identify algorithms and techniques used in different components of Linux

3. Specific Objectives and Contents

Specific Objectives	**Contents**
• Explain Evolution of operating system generation wise • Understand system calls and operating modes of OS • Describe OS structures and open source operating systems	**Unit I: Overview (4)** 1.1. Definition, Two views of operating system, Evolution of operating system, Types of OS. 1.2. System Call, Handling System Calls, System Programs, Types of System Call 1.3. Operating System Structure, The Shell, Open Source Operating Systems
• Differentiate program, process, and threads • Understand process states, process control blocks and thread table • Understand and Simulate inter-process communication IPC and mutual exclusion.	**Unit II: Process Management (10)** 2.1. Process vs Program, Multiprogramming, Process Model, Process States, Process Control Block. 2.2. Threads, Thread vs Process, User Space Threads, Kernel Space Threads. 2.3. Inter Process Communication, Race Condition, Critical Section 2.4. Implementing Mutual Exclusion: Mutual Exclusion

- Trace and simulate process scheduling algorithms and compare them - Describe and simulate classical IPC problems	with Busy Waiting (Disabling Interrupts, Lock Variables, Strict Alteration, Peterson's Solution, Test and Set Lock), Sleep and Wakeup, Semaphore, Monitors, Message Passing, Classical IPC problems (Producer Consumer, Sleeping Barber, Dining Philosopher Problem) 2.5. Process Scheduling: Goals, Batch System Scheduling (First-Come First-Served, Shortest Job First, Shortest Remaining Time Next), Interactive System Scheduling (Round-Robin Scheduling, Priority Scheduling, Multiple Queues), Evaluating Scheduling Algorithms, Overview of Real Time System Scheduling.
- Characterize and simulate deadlock occurrence. - Understand deadlock prevention and avoidance techniques - Enable to apply deadlock detection and recovery techniques.	**Unit III: Process Deadlocks (6)** 3.1. Introduction, Deadlock Characterization, Preemptable and Nonpreemptable Resources, Resource – Allocation Graph, Conditions for Deadlock 3.2. Handling Deadlocks: Ostrich Algorithm, Deadlock prevention, Deadlock Avoidance (Safe and Unsafe States, Bankers Algorithm for Single and Multiple Resource Instances) , Deadlock Detection (For Single and Multiple Resource Instances), Recovery From Deadlock (Through Preemption and Rollback)
- Analyze and understand impact of multiprogramming in resource utilization - Describe memory management and allocation techniques - Understand virtual memory, paging and segmentation. - Demonstrate and simulate page replacement algorithms	**Unit IV: Memory Management (8)** 4.1. Introduction, Monoprogramming vs Multi-programming, Modelling Multiprogramming, Multiprogramming with fixed and variable partitions, Relocation and Protection. 4.2. Memory management (Bitmaps & Linked-list), Memory Allocation Strategies 4.3. Virtual memory: Paging, Page Table, Page Table Structure, Handling Page Faults, TLB's 4.4. Page Replacement Algorithms: FIFO, Second Chance, LRU, Optimal, LFU, Clock, WS-Clock, Concept of Locality of Reference, Belady's Anomaly 4.5. Segmentation: Why Segmentation?, Drawbacks, Segmentation with Paging(MULTICS)
- Describe file and directory concept - Understand and simulate file and directory implementation strategies. - Exemplify disk free space management techniques	**Unit V: File Management (6)** 5.1. File Overview: File Naming, File Structurte, File Types, File Access, File Attributes, File Operations, Single Level, two Level and Hierarchical Directory Systems, File System Layout. 5.2. Implementing Files: Contiguous allocation, Linked List Allocation, Linked List Allocation using Table in Memory, Inodes.

	5.3. Directory Operations, Path Names, Directory Implementation, Shared Files 5.4. Free Space Management: Bitmaps, Linked List
• Describe device types and structures. • Understand Interrupts, DMA and IO software • Demonstrate IO handling techniques • Exemplify and simulate disk scheduling algorithms	**Unit VI: Device Management (6)** 6.1. Classification of IO devices, Controllers, Memory Mapped IO, DMA Operation, Interrupts 6.2. Goals of IO Software, Handling IO(Programmed IO, Interrupt Driven IO, IO using DMA), IO Software Layers (Interrupt Handlers, Device Drivers) 6.3. Disk Structure, Disk Scheduling (FCFS, SSTF, SCAN, CSCAN, LOOK, CLOOK), Disk Formatting (Cylinder Skew, Interleaving, Error handling), RAID
• Correlate above knowledge with Linux operating system	**Unit VII: Linux Case Study (5)** 7.1. History, Kernel Modules, Process Management, , Scheduling, Inter-process Communication, Memory Management, File Systems

Evaluation System

Undergraduate Programs							
External Evaluation	**Marks**	**Internal Evaluation**	**Weightage**	**Marks**	**Practical**	**Weightage**	**Mark**
End semester examination	60	Assignments	20%	20	Practical Report copy	25%	20
(Details are given in the separate table at the end)		Quizzes	10%		Viva	25%	
		Attendance	20%		Practical Exam	50%	
		Internal Exams	50%				
Total External	60	Total Internal	100%	20		100%	20
Full Marks 60+20+20 = 100							

External evaluation

1. **End semester examination:**

   It is a written examination at the end of the semester. The questions will be asked covering all the units of the course. The question model, full marks, time and others will be as per the following grid.

2. **External Practical Evaluation:**
   After completing the end semester theoretical examination, practical examination will be held. External examiner will conduct the practical examination according to the above mentioned evaluation. There will be an internal examiner to assist the external examiner. Three hours time will be given for the practical examination. In this examination Students must demonstrate the knowledge of the subject matter.

Full Marks: 100, Pass Marks: 45, Time: 3 Hrs

Nature of question	**Total questions to be asked**	**Total questions to be answered**	**Total marks**	**Weightage**
Group A: multiple choice*	20	20	20×1 = 20	60%
Group B: Short answer type questions	7	6	6×8 = 48	60%
Group C: Long answer type question/long menu driven programs	3	2	2×16 =32	60%
			100	100%

Each student must secure at least 50% marks in internal evaluation in order to appear in the end semester examination. Failed student will not be eligible to appear in the end semester examinations.

Internal evaluation

Assignment: Each student must submit the assignment individually. The stipulated time for submission of the assignment will be seriously taken.

Quizzes: Unannounced and announced quizzes/tests will be taken by the respective subject teachers. Such quizzes/tests will be conducted twice per semester. The students will be evaluated accordingly.

Attendance in class: Students should regularly attend and participate in class discussion. Eighty percent class attendance is mandatory for the students to enable them to appear in the end semester examination. Below 80% attendance in the class will signify NOT QUALIFIED (NQ) to attend the end semester examination.

Presentation: Students will be divided into groups and each group will be provided with a topic for presentation. It will be evaluated individually as well as group-wise. Individual students have to make presentations on the given topics.

Mid-term examination: It is a written examination and the questions will be asked covering all the topics in the session of the course.

Discussion and participation: Students will be evaluated on the basis of their active participation in the classroom discussions.

Instructional Techniques: All topics are discussed with emphasis on real-world application. List of instructional techniques is as follows:

- Lecture and Discussion
- Group work and Individual work
- Assignments
- Presentation by Students
- Quizzes
- Guest Lecture

Students are advised to attend all the classes and complete all the assignments within the specified time period. If a student does not attend the class(es), it is his/her sole responsibility to cover the topic(s) taught during that period. If a student fails to attend a formal exam/quiz/test, there won't be any provision for re-exam.

Laboratory Work

Student should simulate at least 15 algorithms discussed in class, prepare lab sheet for each of the algorithm simulated in lab. Minimum 3 lab hour per week in required. Algorithms to be simulated can be decided by instructor, but it must cover IPC, process scheduling, Page Replacement, Free Space management, File System, and deadlock.

Prescribed Text

- *Modern Operating Systems:* Andrew S. Tanenbaum, PH1 Publication, Third edition, 2008

Reference

- *Abraham Silberschatz, Peter Baer Galvin and Greg Gagne, "*Operating System Concepts", John Wiley & Sons (ASIA) Pvt. Ltd, Seventh edition, 2005.
- *Harvey M. Deitel, Paul J. Deitel, and David R. Choffnes,* "Operating Systems", Prentice Hall, Third edition, 2003.