

A. Course Handout (Version 1.0) | Last updated on 5th March, 2022

Institute/School Name	Chitkara University Institute of Engineering and Technology		
Department Name	Computer Science & Engineering		
Programme Name	Bachelor of Engineering (B.E) - Computer Science & Engineering		
Course Name	Operating System Fundamentals with LINUX	Session	2021-2022
Course Code	CS182	Semester/Batch	2 nd /2021
L-T-P (Per Week)	3-0-2	Course Credits	4
Course Coordinator	Dr. Vinay Kukreja		

1. Scope and Objectives of the Course

This course focuses on fundamental design and implementation ideas in the engineering of operating systems. Topics include virtual memory, threads, context switches, kernels, interrupts, system calls, interprocess communication, coordination, and the interaction between software and hardware. The main objectives of the course are to:

- Impart a structured approach to understand the concepts of operating system.
- Expose students to concurrent programming issues in the management of resources like processor, memory and input-output
- Provide skills required as a foundation to build solutions for real-world engineering problems. • Enable learners to understand different Linux operating commands along with their usage.

2. Course Learning Outcomes

After completion of the course, students will be able to do the following:

CLO01: Compare different types of Operating System and identify their components.

CLO02: Comprehend the concept of process, principle of concurrency

CLO03: Appraise various scheduling algorithms and deadlock handling techniques

CLO04: Epitomize memory management techniques

CLO05: Understand the concept of disk scheduling, file system and I/O devices

CLO-PO mapping grid

Course Learning Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CLO1		H	H									H
CLO2		H	H		H							
CLO3	M	H	H				M					
CLO4		H		M	H				H			

CLO5	M	H	M			M		M		M	M	
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3. Recommended Books (Reference Books/Text Books):

B01: Operating System Concepts, Abraham Silberschatz, Peter Baer Galvin, and Greg Gagne, 9th Edition, 2018, Wiley.

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B02: System Programming and Operating Systems, D.M. Dhamdhere, 2nd Edition, 2009, Tata McGraw Hill.

B03: Operating Systems: Internals and Design Principles, William Stallings, 9th Edition, 2018, Pearson. **B04:** Modern Operating Systems, Andrew S. Tanenbaum, 4th Edition, 2016, Pearson.

B05: Advanced Linux Programming, Mark Mitchell, Jeffrey Oldham, and Alex Samuel, 1st Edition, 2001 Germany: New Riders.

B06: Linux Command Line and Shell Scripting Bible, Richard Blum and Christine Bresnahan, 3rd Edition, 2015, Wiley.

4. Other readings and relevant websites:

S.No.	Link of Journals, Magazines, websites and Research Papers
1.	https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-828-operating-system-engineering-fall-2012/download-course-materials/
2.	http://nptel.ac.in/courses/106108101/
3.	http://www.ics.uci.edu/~ics143/lectures.html
4.	http://www.cs.kent.edu/~farrell/osf03/oldnotes/index.html
5.	http://williamstallings.com/OS/OS6e.html
6.	https://learning.edx.org/course/course-v1:LinuxFoundationX:LFS101x+1T2017
7.	https://nptel.ac.in/courses/106/105/106105214/

5. Recommended Tools and Platforms

VirtualBox 6.1.22, Ubuntu 21.04, GCC Compiler

6. Course Plan:

Lecture Number	Topics	Recommended Book / Other reading material	Page numbers of Text Book(s)
1-2	Introduction: Introduction to Operating systems, Operating System role, Computer system architecture: Single processor, Multiprocessor Systems, Clustered Systems.	B01	3-5, 12-18
3	OS structure, OS operations, Components of OS: Process management, memory management, storage management, I/O management, Protection and security. Computing	B01 Link 1	19-31

	Environment.		
4-5	Operating System Services, User and OS interface, System Calls/API, Types of System Call, System Program	B01	53-73
6	Process Concept: Process Scheduling, Operations On Processes,	B01 B03 B04 Link 2	103-128 320-326, 447-453 108-140
7	Inter-process Communication	B01	141-150
8	Threads: Overview of Threads, Multicore Programming, Multithreading Models, Threading issues, Linux Threads	B01 B04 Link 5	161-169, 181-188, 144-145 161-174, 195-198
9	CPU Scheduling: Basic Concepts, Scheduling Criteria Scheduling Algorithms-, First In first Out Scheduling Algorithms (FIFO),	B01 B03 B04 Link 7	201-208 343-347, 406-416
10-11	Shortest Job First Scheduling Algorithms (SJF), Priority Scheduling	B01	209

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	Algorithms,		
12	Scheduling Algorithms- Round-robin Scheduling Algorithms, Multilevel Queue Scheduling, Multilevel Feedback Scheduling, Multiple-Processor, Scheduling Real Time Scheduling	B01 B03 B04 Link 7	210-216 347-368 417-432, 453-481
13-14	Process Synchronization: Background, The Critical-Section Problem, Two process solution, Multiple Process solution, Synchronization Hardware.	B01 RB2 Link 3 Link 2	253-259 189-197
15	Semaphores	B01	259-263
ST-1 (Lecture 1- Lecture 15)			
16-17	Classic problems of Synchronization, Critical regions, Monitors	B01 B02 B03	263-281 197-222 396-432
18	Deadlock: System Model Deadlock Characterization,	B01 B02 B03 B05, Link 7	311-318 143-250 371-395 168-173
19-20	Methods for handling Deadlocks	B01	318-319
21	Deadlock Prevention, Deadlock avoidance,	B01 B02	319-334 250-265

		B05	168-183
22	Deadlock detection, Recovery From Deadlocks	B01	320-344
23-24	Memory Management: Basics, Swapping, Contiguous memory allocation, Segmentation	B01 B02 B04	345-360 273-308 326-331
25	Paging	B01	360-365
26-27	Segmentation, Segmentation with paging	B01 B02, Link 4	366-376 309-312
28-30	Introduction to Virtual Memory, Demand Paging, Process creation: Copy- on write	B01 B02 B05	389-401 317-330 202-222
31-32	Page Replacement Algorithms, Allocation of frames, Thrashing	B01 B02 B05	401-422 330-353 202-222
ST-2 (Lecture 16- Lecture 30)			
33	File System : File Concept, Access Methods, Directory Structure, File System Mounting, File Sharing, Protection	B01 B02 B05 B04	455-490 371-406 382-398 552-579
34-35	Implementing File System: File System Structure, File System. Implementation, Directory implementation, Allocation Methods, Free-space Management	B01 B02 B05	495-515 411-433 399-428
36	Mass Storage structure: Overview, Disk Structure, Disk attachment, Disk Scheduling, Disk Management, Swap-Space Management	B01 B02 B05 B01	539-556 491-504 269-324 557-580
ST-3 (Lecture 1- Lecture 36)			
ETE (Lecture 1- Lecture 36)			

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7. Lab Plan

Sr. No.	Lab Number	Experiments	Learning Resource
1	1-2	Installation: Configuration & Customizations of Linux	https://ubuntu.com/tutorials/install-ubuntu-server#1-overview
2	3-4	Implement the basic and user status commands like: su, sudo, man, help, history, who, whoami, id, uname, uptime, free, tty, cal, date, hostname, reboot, clear, bc.	https://techlog360.com/basic-ubuntu-commands-terminal-shortcuts-linux-beginner/

3	5-6	File system: Introduction to File system, File system Architecture and File Types.	https://tldp.org/LDP/intro/linux/html/sect_03_01.html
4	7-8	Implement the commands that is used for Creating and Manipulating files: cat, cp, mv, rm, ls and its options, touch and their options, which is, where is, what is	http://tldp.org/LDP/abs/html/basic.html
5	9-10	Implement Directory oriented commands: cd, pwd, mkdir, rmdir	http://litux.nl/Reference/Books/7213/ddu0082.html
6	11-12	Implement File system commands: Comparing Files using diff, cmp, comm	https://www.geeksforgeeks.org/cmp-command-in-linux-with-examples/ https://www.geeksforgeeks.org/diff-command-linux-examples/
7	13-14	Implementation of Compressing files: tar, gzip,	https://mkyong.com/linux/how-to-zip-unzip-tar-in-unix-linux/
8	15-16	Usage of these commands along with its working: bzip2, compress, uncompress files.	https://www.tecmint.com/linux-compress-decompress-bz2-files-using-bzip2/
9	17-18	Text Editors: gedit, vi, vim editor (Insert Text, delete text, Navigation, copy-paste, cut-paste, search operation)	https://www.computernetworkingnotes.com/linux-tutorials/vi-and-vim-text-editors-commands-explained.html
10	19-20	Apply different Searching commands: Search file or directory in directory structure using find and locate command with various options, wildcards *, ?, [], !	https://www.geeksforgeeks.org/difference-between-locate-which-and-find-command-in-linux/
11	21-22	Implementation of Managing Users commands: Types: Super, Owner, Group, Others, Adding user	https://www.tecmint.com/manage-users-and-groups-in-linux/
12	23-24	Implement commands for Removing user, Working with Passwords, expiry dates using usermod.	https://www.geeksforgeeks.org/user-management-in-linux/

8. Delivery/Instructional Resources

Lecture Number	Topics	PPT (link of ppts on the	Industry Expert Session/ If yes: link of	Web References	Audio-Video
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		central server)	ppts on the		
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			<i>central server)</i>		
1-2	Introduction: Introduction to Operating systems, Operating System role, Computer system architecture: Single processor, Multiprocessor Systems, Clustered Systems.			https://nptel.ac.in/courses/106/108/106108101/	https://nptel.ac.in/courses/106/105/106105214/
3	OS structure, OS operations, Components of OS: Process management, memory management, storage management, I/O management, Protection and security. Computing Environment.			https://nptel.ac.in/courses/106/108/106108101/	https://nptel.ac.in/courses/106/105/106105214/
4-5	Operating System Services, User and OS interface, System Calls/API, Types of System Call, System Program			https://nptel.ac.in/courses/106/108/106108101/	https://nptel.ac.in/courses/106/105/106105214/
6	Process Concept: Process Scheduling, Operations On Processes,			https://nptel.ac.in/courses/106/108/106108101/	https://nptel.ac.in/courses/106/105/106105214/
7	Inter-process Communication			https://nptel.ac.in/courses/106/108/106108101/	https://nptel.ac.in/courses/106/105/106105214/
8	Threads: Overview of Threads, Multicore Programming, Multithreading Models, Threading issues, Linux Threads			https://nptel.ac.in/courses/106/108/106108101/	https://nptel.ac.in/courses/106/105/106105214/

9	CPU Scheduling: Basic Concepts, Scheduling Criteria Scheduling Algorithms-, First In first Out Scheduling Algorithms (FIFO),			https://nptel.ac.in/courses/106/108/106108101/	https://nptel.ac.in/courses/106/105/106105214/
10-11	Shortest Job First Scheduling Algorithms (SJF), Priority Scheduling			https://nptel.ac.in/courses/106/108/106108101/	https://nptel.ac.in/courses/106/105/106105214/

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	Algorithms,				
12	Scheduling Algorithms- Round robin Scheduling Algorithms, Multilevel Queue Scheduling, Multilevel Feedback Scheduling, Multiple Processor , Scheduling Real Time Scheduling			https://nptel.ac.in/courses/106/108/106108101/	https://nptel.ac.in/courses/106/105/106105214/
13-14	Process Synchronization: Background, The Critical-Section Problem, Two process solution, Multiple Process solution, Synchronization Hardware.			https://nptel.ac.in/courses/106/108/106108101/	https://nptel.ac.in/courses/106/105/106105214/
15	Semaphores			https://nptel.ac.in/courses/106/108/106108101/	https://nptel.ac.in/courses/106/105/106105214/
16-17	Classic problems of Synchronization, Critical regions, Monitors			https://nptel.ac.in/courses/106/108/106108101/	https://nptel.ac.in/courses/106/105/106105214/

18	Deadlock: System Model Deadlock Characterization,			https://nptel.ac.in/courses/106/108/106108101/	https://nptel.ac.in/courses/106/105/106105214/
19-20	Methods for handling Deadlocks			https://nptel.ac.in/courses/106/108/106108101/	https://nptel.ac.in/courses/106/105/106105214/
21	Deadlock Prevention, Deadlock avoidance,			https://nptel.ac.in/courses/106/108/106108101/	https://nptel.ac.in/courses/106/105/106105214/
22	Deadlock detection, Recovery From Deadlocks			https://nptel.ac.in/courses/106/108/106108101/	https://nptel.ac.in/courses/106/105/106105214/
23-24	Memory Management: Basics, Swapping, Contiguous memory allocation, Segmentation			https://nptel.ac.in/courses/106/108/106108101/	https://nptel.ac.in/courses/106/105/106105214/
25	Paging			https://nptel.ac.in/courses/106/108/106108101/	https://nptel.ac.in/courses/106/105/106105214/
26-27	Segmentation,			https://nptel.ac.in/courses/106/108/106108101/	https://nptel.ac.in/courses/106/105/106105214/

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	Segmentation with paging			es/106/108/106108101/	rses/106/105/106105214/
28-30	Introduction to Virtual Memory, Demand Paging, Process creation: Copy- on write			https://nptel.ac.in/courses/106/108/106108101/	https://nptel.ac.in/courses/106/105/106105214/
31-32	Page Replacement Algorithms, Allocation of frames, Thrashing			https://nptel.ac.in/courses/106/108/106108101/	https://nptel.ac.in/courses/106/105/106105214/

33	File System : File Concept, Access Methods, Directory Structure, File System Mounting, File Sharing, Protection			https://nptel.ac.in/courses/106/108/106108101/	https://nptel.ac.in/courses/106/105/106105214/
34-35	Implementing File System: File System Structure, File System. Implementation, Directory implementation, Allocation Methods, Free-space Management			https://nptel.ac.in/courses/106/108/106108101/ https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-828-operating-system-engineering-fall-2012/lecture-notes-and-readings/MIT6_828F12 lec9_notes.pdf	https://nptel.ac.in/courses/106/105/106105214/
36	Mass Storage structure: Overview, Disk Structure, Disk attachment, Disk Scheduling, Disk Management, Swap Space Management.			https://nptel.ac.in/courses/106/108/106108101/	https://nptel.ac.in/courses/106/105/106105214/

9. Action plan for different types of learners

Slow Learners	Average Learners	Advanced Learners
<ul style="list-style-type: none"> • Remedial Class for slow learners. • Encouragement for improvement using peer tutoring. • Individual feedback to each slow learner. 	<ul style="list-style-type: none"> • Doubt Class for average learners • Special Doubt session will be arranged for ST topics. • Doubts of individual student will be resolved. 	<ul style="list-style-type: none"> • Red Hat Academy Courses would be provided to fast learner. • Certification exams will be offered to interested students.

10. Evaluation Scheme & Components:

Evaluation Component	Type of Component	No. of Assessments	Weightage of Component	Mode of Assessment
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Component 1	Formative Assessments (FAs)	03*	20%	Online
Component 2	Subjective Test/Sessional Tests (STs)	03**	30%	Online
Component 3	End Term Examinations	01	50%	Online
Total		100%		

*Out of 03 FAs, the ERP system automatically picks the best 02 FAs marks for evaluation of the FAs as final marks.**Out of 03 STs, the ERP system automatically picks the best 02 STs marks for evaluation of the STs as final marks.

11. Details of Evaluation Components:

Evaluation Component	Description	Syllabus Covered (%)	Timeline of Examination	Weightage (%)
Component 01	FA1	Up to 25%	Week 4	20%
	FA2	26%-50%	Week 7	
	FA3	51%-85%	Week 9	
Component 02	ST 01	Up to 40%	Week 6	30%
	ST 02	41% - 80%	Week 11	
	ST 03	100%	Week 13	
Component 03	End Term Examination*	100%	At the end of the semester	50%
Total				100%

*As per Academic Guidelines minimum 75% attendance is required to become eligible for appearing in the End Semester Examination.

Evaluation Components

Type of Assessment	Time of Conduction	Total Marks	Question Paper Format			
			1 Mark MCQ	2 Mark MCQ	5 Mark Algorithm/Coding	10 Mark Algorithm/Coding
Formative Assessment 1	Week 4	20	10	5	-	-
Sessional Test 1	Week 6	30	20	5	-	-
Formative Assessment 2	Week 7	20	-	-	-	-
Formative Assessment 3	Week 9	20	10	5	-	-

Sessional Test 2	Week 11	30	20	5	-	-
Sessional Test 3	Week 13	30	20	5	-	-

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End Term Examination	50	30	10	-	-
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12. Syllabus of the Course:

Lecture Number	Topics	No of Lectures	Weightage
1-5	Introduction: Introduction to Operating systems, Operating System role, Computer system architecture: Single processor, Multiprocessor Systems, Clustered Systems. OS structure, OS operations, Components of OS: Process management, memory management, storage management, I/O management, Protection and security. Computing Environment. Operating System Services, User and OS interface, System Calls/API, Types of System Call, System Program	5	18%
6-7	Process Concept: Process Scheduling, Operations On Processes, Inter-process Communication	2	
8	Threads: Multithreading Models, Overview, Threading issues, Linux Threads	1	13%
9-12	CPU Scheduling: Basic Concepts, Scheduling Criteria Scheduling Algorithms Multiple-Processor, Scheduling Real Time Scheduling	4	
13-15	Process Synchronization: Background, The Critical-Section Problem, Two process solution, Multiple Process solution, Synchronization Hardware, Semaphores	3	26%
16-17	Classic problems of Synchronization, Critical regions, Monitors	2	
18-22	Deadlock: System Model Deadlock Characterization, Methods for handling Deadlocks, Deadlock Prevention, Deadlock avoidance, Deadlock detection, Recovery from Deadlocks	5	
23-27	Memory Management: Basics, Swapping, Contiguous memory allocation, Segmentation. Paging, Segmentation with paging.	5	26%
28-32	Introduction to Virtual Memory, Demand Paging, Process creation: Copy- on write, Page Replacement Algorithms, Allocation of frames, Thrashing.	5	

33-35	File Concept: File Concept, Access Methods, Directory Structure, File System Mounting, File Sharing, Protection, Implementing File System: File System Structure, File System. Implementation, Directory implementation, Allocation Methods, Free-space Management	3	17%
36	Mass Storage structure: Overview, Disk Structure, Disk attachment, Disk Scheduling, Disk Management, Swap-Space Management.	1	

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13. Course Execution Plan (Faculty)

Lecture Number	Topics	Date of delivery	Remarks (if any)
1-2	Introduction: Introduction to Operating systems, Operating System role, Computer system architecture: Single processor, Multiprocessor Systems, Clustered Systems.		
3	OS structure, OS operations, Components of OS: Process management, memory management, storage management, I/O management, Protection and security. Computing Environment.		
4-5	Operating System Services, User and OS interface, System Calls/API, Types of System Call, System Program		
6	Process Concept: Process Scheduling, Operations On Processes,		
7	Inter-process Communication		
8	Threads: Overview of Threads, Multicore Programming, Multithreading Models, Threading issues, Linux Threads		
9	CPU Scheduling: Basic Concepts, Scheduling Criteria Scheduling Algorithms-, First In first Out Scheduling Algorithms (FIFO),		
10-11	Shortest Job First Scheduling Algorithms (SJF), Priority Scheduling Algorithms,		
12	Scheduling Algorithms- Round-robin Scheduling Algorithms, Multilevel Queue Scheduling, Multilevel Feedback Scheduling, Multiple-Processor, Scheduling Real Time Scheduling		
13-14	Process Synchronization: Background, The Critical-Section Problem, Two process solution, Multiple Process solution, Synchronization Hardware.		

15	Semaphores		
16-17	Classic problems of Synchronization, Critical regions, Monitors		
18	Deadlock: System Model Deadlock Characterization,		
19-20	Methods for handling Deadlocks		
21	Deadlock Prevention, Deadlock avoidance,		
22	Deadlock detection, Recovery from Deadlocks		
23-24	Memory Management: Basics, Swapping, Contiguous memory allocation, Segmentation		
25	Paging		
26-27	Segmentation, Segmentation with paging		
28-30	Introduction to Virtual Memory, Demand Paging, Process creation: Copy- on write		
31-32	Page Replacement Algorithms, Allocation of frames, Thrashing		
33	File System: File Concept, Access Methods, Directory Structure, File System Mounting, File Sharing, Protection		
34-35	Implementing File System: File System Structure, File System. Implementation, Directory implementation,		

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	Allocation Methods, Free-space Management		
36	Mass Storage structure: Overview, Disk Structure, Disk attachment,		

14. Lab Execution Plan (Faculty)

Lecture Number	Experiments	Date of delivery	Remarks (if any)
1-2	Installation: Configuration & Customizations of Linux		
3-4	Implement the basic and user status commands like: su, sudo, man, help, history, who, whoami, id, uname, uptime, free, tty, cal, date, hostname, reboot, clear, bc.		
5-6	File system: Introduction to File system, File system Architecture and File Types.		

7-8	Implement the commands that is used for Creating and Manipulating files: cat, cp, mv, rm, ls and its options, touch and their options, which is, where is, what is		
9-10	Implement Directory oriented commands: cd, pwd, mkdir, rmdir		
11-12	Implement File system commands: Comparing Files using diff, cmp, comm		
13-14	Implementation of Compressing files: tar, gzip,		
15-16	Usage of these commands along with its working: bzip2, compress, uncompress files.		
17-18	Text Editors: gedit, vi, vim editor (Insert Text, delete text, Navigation, copy-paste, cut-paste, search operation)		
19-20	Apply different Searching commands: Search file or directory in directory structure using find and locate command with various options, wildcards *, ?, [], !		
21-22	Implementation of Managing Users commands: Types: Super, Owner, Group, Others, Adding user		
23-24	Implement commands for Removing user, Working with Passwords, expiry dates using usermod.		

This Document is approved by:

Designation	Name	Signature
Course Coordinator	Dr. Vinay Kukreja	
Head Academic Delivery	Dr. Vinay Gautam	
Cluster Dean	Dr. Raj Gaurang	
Dean (Academics Affairs)	Dr. Rajnish Sharma	
Date	05.03.2022	

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