

**MANIPAL UNIVERSITY JAIPUR**School of Computing and IT

Department of Computer Science and Engineering  
Course Hand-out

Operating Systems | CS 1401 | 4 Credits | 3 0 1 3

Session: Jan 19 – May 19 | Class: IV Semester (Program Core)

1. **Introduction:** This course is offered by Dept. of Computer Science and engineering as a department core subject. The course provides a comprehensive understanding of Operating System principles, techniques and approaches used for designing the software. The focus of the course is to make the students understand how various components of operating system interact and provides services for execution of application software. Student will be apprised of process management, deadlock, concurrency control, memory management, file management and I/O management in detail, which will be beneficial for software development.
2. **Course Outcomes:** At the end of the course, students will be able to
3. Describe the objectives, structure, functionality and types of operating systems.
4. Write system programs using file and process system calls and PThread API.
5. Compare various algorithms used for process scheduling.
6. Describe concepts related to concurrency and achieve the same for cooperating processes, Apply various deadlock handling strategies to solve resource allocation problems.
7. Evaluate the performance of different memory management techniques and page replacement algorithms.
8. Describe file concepts and analyse various disk scheduling and storage strategies.
9. **PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES** 
   1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems
   2. **Problem analysis**: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences
   3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations
   4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions
   5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations
   6. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice
   7. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development
   8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practices
   9. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings
   10. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions
   11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one’s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments
   12. **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change
10. Will be able to design, develop and implement efficient software for a given real life problem.
11. Will be able to apply knowledge of AI, Machine Learning and Data Mining in analysing big data for extracting useful information from it and for performing predictive analysis.
12. Will be able to design, manage and secure wired/ wireless computer networks for transfer and sharing of information.
13. **Assessment Plan:**

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| **Criteria** | **Description** | **Maximum Marks** |
| Internal Assessment (Summative) | Sessional Exam I (Open Book) | 15 |
| Sessional Exam II (Open Book) | 15 |
| Quizzes and Assignments (Accumulated and Averaged) | 30 |
| End Term Exam  (Summative) | End Term Exam (Open Book) | 40 |
|  | Total | 100 |
| Attendance  (Formative) | A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves. | |
| Make up Assignments  (Formative) | Students who misses a class will have to report to the teacher about the absence. A makeup assignment on the topic taught on the day of absence will be given which has to be submitted within a week from the date of absence. No extensions will be given on this. The attendance for that particular day of absence will be marked blank, so that the student is not accounted for absence. These assignments are limited to a maximum of 5 throughout the entire semester. | |
| Homework/ Home Assignment/ Activity Assignment  (Formative) | There are situations where a student may have to work in home, especially before a flipped classroom. Although these works are not graded with marks. However, a student is expected to participate and perform these assignments with full zeal since the activity/ flipped classroom participation by a student will be assessed and marks will be awarded. | |

1. **SYLLABUS**

**Introduction:** Operating system structure, Operating system operations, Process management, Memory management, Storage management, Protection and security, Special purpose systems. **System structure:** Operating system services, User operating system interfaces, System calls, Types of system calls, System programs, Operating system structure, Virtual machines, System boot. **Process:** Process Concept, Process scheduling, Operations on processes, Inter-process communication, Unix Pipes. **Multithreaded Programming:** Multithreaded models, Thread libraries, Programs using PThreads. **Process scheduling:** Basic concepts, scheduling criteria, Scheduling algorithms. **Process Synchronization:** Critical section problem, Peterson’s solution, Synchronization Hardware, Semaphores, Classical problems of synchronization, Synchronization programs using PThreads. **Deadlocks:** System model, Deadlock Characterization, Methods for handling deadlocks, Deadlock prevention, Deadlock avoidance, Deadlock detection, Recovery from deadlock. **Memory Management:** Background, Swapping, Contiguous Memory Allocation, Paging, Structure of Page Table, Segmentation, Demand Paging, Page Replacement Policies, Allocation of Frames, Thrashing**. File System Interface and Implementation:** File Concept, Access Methods, Directory and Disk Structure, File System Mounting, File System Structure, File System Implementation, Space Allocation Methods for Files, Free Space Management. **Disk Management:** Disk Scheduling Algorithms, Disk Management, Swap Space Management. **Protection and Security**: Goals of Protection, Domain of Protection, Access Matrix, Implementation of Access Matrix, Security Problem, User Authentication, Program Threats, System Threats, Intrusion Detection.

1. **TEXT BOOKS**

1. A. Silberschatz, P. B. Galvin and G. Gagne, *“Operating System Concepts”,* 9th Edition, Wiley, 2014.

1. **REFERENCE BOOKS**

1. A.S. Tanenbaum, “Modern Operating Systems”, 3rd Edition, Prentice Hall India.

2. W. Stallings, “Operating Systems”, 7th Edition, Pearson.

3. W. R. Stevens and S. A. Rago, “*Advanced Programming in the UNIX Environment*”, 3rd Edition, Addison-Wesley, 2013.

**I. Lecture Plan:**

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| Lec No | **Topics** | **Session Outcome** | **Mode of Delivery** | **Corresponding CO** | **Mode of Assessing the Outcome** |
| 1 | Introduction and Course Hand-out briefing | To acquaint and clear teachers expectations and understand student expectations | Lecture | NA | NA |
| 2,3 | **Introduction:** Operating system structure, Operating system operations, Process management, Memory management Storage management, Protection and security, Special purpose systems. | Describe the objectives, functionality and different types of operating systems | Lecture | 1401.1 | Quiz  MTE-1  End Term |
| 4,5,6 | **System structure:** Operating system services, User operating system interfaces System calls, Types of system calls, System programs Operating system structure, Virtual machines, System boot. | Explain dual mode CPU operation, execution of system calls, interrupts, various operating system structures and booting process | Lecture | 1401.1 | Quiz  MTE-1  End Term |
| 7,8,9,10,11 | **Process:** Process Concept, Process scheduling Operations on processes Inter-process Communication, Unix Pipes | Describe process state transitions, process control block, and context switching and write system programs for process creation, execution, inter-process communication. | Lecture | 1401.2 | Quiz  MTE-1  End Term  Programming Assignment |
| 12,13,14,15 | **Multithreaded Programming:** Overview, multithreaded models Thread libraries Programs using Pthreads | Describe significance of threads, multithreaded models and write system programs using PThreads | Lecture | 1401.2 | Quiz  MTE-1  End Term  Programming Assignment |
| 16,17, 18, 19, 20 | **Process scheduling:** Basic concepts, scheduling criteria, Scheduling Algorithms. | Compare various algorithms used for process scheduling based on various scheduling criteria | Lecture  Tutorial | 1401.3 | Quiz  Mid Term I  End Term |
| 21, 22, 23, 24, 25 | **Process Synchronization:** Background, Critical section problem Peterson’s solution Synchronization Hardware, Semaphores Classical problems of synchronization. Programs using PThreads | Apply concepts related to concurrency to achieve the same for cooperating processes | Lecture  Tutorial | 1401.4 | Quiz  MTE-2  End Term  Tutorial |
| 26, 27 | Synchronization Programs using PThreads | Write programs for synchronization problems | Lecture | 1401.4 | Quiz  MTE-2  End Term  Project |
| 28, 29, 30, 31 | **Deadlocks:** System model, Deadlock Characterization, Methods for handling deadlocks, Deadlock prevention, Deadlock avoidance, Deadlock detection, Recovery from deadlock. | Apply various deadlock handling strategies to solve resource allocation problems | Lecture  Tutorial | 1401.4 | Quiz  MTE-2  End Term  Tutorial |
| 32, 33, 34, 35, 36 | **Memory Management:** Background, Swapping, Contiguous Memory Allocation, Paging, Structure of Page Table, Segmentation, | Evaluate the performance of different memory management techniques | Lecture  Tutorial | 1401.5 | Quiz  MTE-2  End Term  Tutorial |
| 37, 38, 39, 40, 41 | Demand Paging, Page Replacement Policies, Allocation of Frames, Thrashing**.** | Describe the concept of virtual memory, and compare various page replacement algorithms | Lecture  Tutorial | 1401.5 | Quiz  End Term  Tutorial |
| 42, 43, 44, 46, 47, 48 | **File System Interface and Implementation:** File Concept, Access Methods, Directory and Disk Structure, File System Mounting, File System Structure, File System Implementation, Space Allocation Methods for Files, Free Space Management. | Compare various file allocation methods and free space management techniques | Lecture  Tutorial | 1401.6 | Quiz  End Term |
| 49, 50, 51 | **Disk Management:** Disk Scheduling Algorithms, Disk Management, Swap Space Management. | Analyse various disk scheduling strategies | Lecture  Tutorial | 1401.6 | Quiz  End Term |
| 52, 53, 54 | **Protection and Security:** Goals of Protection, Domain of Protection, Access Matrix, Implementation of Access Matrix, Security Problem, User Authentication, Program Threats, System Threats, Intrusion Detection |  |  |  |  |

1. **Course Articulation Matrix: (Mapping of COs with POs)**

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| **CO** | **STATEMENT** | CORRELATION WITH PROGRAM OUTCOMES | | | | | | | | | | | | CORRELATION WITH PROGRAM SPECIFIC OUTCOMES | | |
| PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
| CS 1401.1 | Describe the objectives, structure, functionality and types of operating systems. | 2 | 1 | 1 |  | 1 |  |  |  |  |  |  | 2 | 1 | 1 | 1 |
| CS 1401.2 | Write system programs using file and process system calls and PThread API. | 2 | 2 | 3 |  | 1 |  |  |  |  | 1 | 1 | 2 | 1 |  | 2 |
| CS 1401.3 | Compare various algorithms used for process scheduling. | 2 | 2 | 2 |  | 1 |  |  |  |  |  |  | 2 | 1 |  | 1 |
| CS 1401.4 | Describe concepts related to concurrency and achieve the same for cooperating processes, Apply various deadlock handling strategies to solve resource allocation problems. | 2 | 2 | 2 | 1 | 1 |  |  |  |  |  |  | 2 | 1 |  | 1 |
| CS 1401.5 | Evaluate the performance of different memory management techniques and page replacement algorithms. | 2 | 2 | 2 | 1 | 1 |  |  |  |  | 1 | 1 | 2 | 1 |  | 1 |
| CS 1401.6 | Describe file concepts and analyse various disk scheduling and storage strategies. | 2 | 2 | 2 | 1 | 1 |  |  |  |  | 1 | 1 | 2 | 1 |  | 1 |

1. **Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation**