OPERATING SYSTEMS (CS403PC)
COURSE PLANNER

Course Overview:

This **course** will introduce the core concepts of **operating systems**, such as processes and threads, scheduling, synchronization, memory management, file **systems**, input and output device management and security. The goal of the programming assignments is to give students some exposure to **operating system** code.

Prerequisite:

To understand the basic computer organization, operating system structures, processes and threads.

Course Objective:

This course OPERATING SYSTEMS is an essential part of any Computer-Science education. The purpose of this course is to understand the mechanisms of the Operating Systems like Process Management, Process Synchronization, Memory Management, File System Implementation, Storage Structures used in OS and Protection Principles. How effectively the OS is utilizing the CPU resources with the help of these mechanisms.

Course Outcome

S. No.	Course Outcomes (CO)	Blooms Taxonomy Level
After completing this course the student must demonstrate the knowledge and ability to:		
CO1	Will be able to control access to a computer and the files that may be shared.	Remember
CO2	Demonstrate the knowledge of the components of computer and their respective roles in computing.	Understand
CO3	Ability to recognize and resolve user problems with standard operating environments	Understand
CO4	Gain practical knowledge of how programming languages, operating systems, and architectures interact and how to use each effectively	Analyze
CO5	Understand the functionality of file systems	Understand

How Program Outcomes are Assessed:

Program Outcomes (PO)		Level	Proficiency assessed by
PO1	**Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	Assignments, Tutorials, Mock Tests
PO2	**Problem Analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	2	Assignments, Tutorials

PO3	**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.	3	Assignments, Tutorials, Mock Tests
PO4	**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.	3	Assignments, Tutorials, Mock Tests
PO5	**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.	3	Assignments, Tutorials, Mock Tests
PO6	**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.	-	-
PO7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental context, and demonstrate the knowledge of, and need for sustainable development.	-	-
PO8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	-	-
PO9	**Individual and team network:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	-	-
PO10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.	-	-
PO11	**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.		
PO12	**Life-Long learning:** Recognize the need for, and have the preparation and able to engage in independent and life-long learning in the broadest context of technological change.	-	-

How Program Specific Outcomes are Assessed:

Program Specific Outcomes (PSO)		Level	Proficiency assessed by
PSO1	**Foundation of mathematical concepts**: To use mathematical methodologies to crack problem using suitable mathematical analysis, data structure and suitable algorithm.	3	Assignments, Tutorials, Mock Tests
PSO2	**Foundation of Computer Science:** The ability to interpret the fundamental concepts and methodology of computer systems. Students can understand the functionality of hardware and software aspects of computer systems.	2	Assignments, Tutorials
PSO3	**Foundation of Software development:** The ability to grasp the software development lifecycle and methodologies of software systems. Possess competent skills and knowledge of software design process.	3	Assignments, Tutorials, Mock Tests

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) - : None

Course Contents

JNTU Syllabus

UNIT - I

Operating System - Introduction, Structures - Simple Batch, Multiprogrammed, Time-shared, Personal Computer, Parallel, Distributed Systems, Real-Time Systems, System components, Operating System services, System Calls

UNIT - II

Process and CPU Scheduling - Process concepts and scheduling, Operations on processes, Cooperating Processes, Threads, and Interposes Communication, Scheduling Criteria, Scheduling Algorithms, Multiple - Processor Scheduling.

System call interface for process management-fork, exit, wait, waitpid, exec

UNIT - III

Deadlocks - System Model, Deadlocks Characterization, Methods for Handling Deadlocks, Deadlock Prevention, Deadlock Avoidance, Deadlock Detection, and Recovery from Deadlock

Process Management and Synchronization - The Critical Section Problem, Synchronization Hardware, Semaphores, and Classical Problems of Synchronization, Critical Regions, Monitors

Inter process Communication Mechanisms: IPC between processes on a single computer system, IPC between processes on different systems, using pipes, FIFOs, message queues, shared memory.

UNIT - IV

Memory Management and Virtual Memory - Logical versus Physical Address Space, Swapping, Contiguous Allocation, Paging, Segmentation, Segmentation with Paging, Demand Paging, Page Replacement, Page Replacement Algorithms.

UNIT - V

File System Interface and Operations -Access methods, Directory Structure, Protection, File System Structure, Allocation methods, Free-space Management. Usage of open, create, read, write, close, lseek, stat, ioctl system calls

TEXT BOOKS:

1. Operating System Principles- Abraham Silberchatz, Peter B. Galvin, Greg Gagne 7th Edition, John Wiley
2. Advanced programming in the UNIX environment, W.R. Stevens, Pearson education.

REFERENCE BOOKS:

1. Operating Systems – Internals and Design Principles Stallings, Fifth Edition–2005, Pearson Education/PHI
2. Operating System A Design Approach- Crowley, TMH.
3. Modern Operating Systems, Andrew S. Tanenbaum 2nd edition, Pearson/PHI
4. UNIX programming environment, Kernighan and Pike, PHI/ Pearson Education
5. UNIX Internals -The New Frontiers, U. Vahalia, Pearson Education.

Lesson Plan:

Lecture No.	Unit No.	Topics to be covered	Course Learning Outcomes	Reference
1	I	Operating System - Introduction	L1:Remember	T1
2		Structures		
3		Simple Batch Systems	L1:Remember	
4		Multi-programmed Systems	L1:Remember	
5		Time-shared Systems	L1:Remember	
6		Personal Computer Systems	L1:Remember	
7		Parallel, Distributed Systems	L1:Remember	
8		Real-Time Systems	L1:Remember	
9		System components	L1:Remember	
10		Operating System services	L1:Remember	

11		System Calls	L1:Remember	
12		Tutorial / Bridge Class #1	L2:Understand	
13	**II**	Process and CPU Scheduling	L2:Understand	**T1**
14		Process concepts	L2:Understand	
15		Scheduling, Operations on processes	L2:Understand	
16		Cooperating Processes	L2:Understand	
17		Threads, and Interposes Communication	L2:Understand	
18		Threads, and Interposes Communication	L2:Understand	
19		Scheduling Criteria	L2:Understand	
20	**II**	Scheduling Algorithms	L2:Understand	**T1**
21		Tutorial / Bridge Class #2	L2:Understand	
22		Scheduling Algorithms	L2:Understand	
23		Multiple -Processor Scheduling	L2:Understand	
24		System call interface for process management	L2:Understand	
25		fork, exit, wait, waitpid, exec	L2:Understand	
26	**III**	Deadlocks - System Model, Deadlocks Characterization	L2:Understand	**T1**
27		Methods for Handling Deadlocks	L2:Understand	
28		Tutorial / Bridge Class #3	L2:Understand	
29		Deadlock Prevention, Deadlock Avoidance,	L2:Understand	
30	**III**	Deadlock Detection, and Recovery from Deadlock	L2:Understand	**T1**
31		Revision 1 and 2nd Unit	L2:Understand	
32		Process Management and Synchronization - The Critical Section Problem	L2:Understand	
33		Synchronization Hardware,	L2:Understand	

		Semaphores		**T1**
34		Classical Problems of Synchronization	L2:Understand	
35		Critical Regions, Monitors	L2:Understand	
36		Inter process Communication Mechanisms: IPC between processes on a single computer system,	L2:Understand	
37		IPC between processes on different systems	L2:Understand	
38		Using pipes, FIFOs	L2:Understand	
39		Message queues, shared memory	L2:Understand	
40		Memory Management and Virtual Memory Introduction	L3:Analyze	
41		Memory Management and Virtual Memory	L3:Analyze	
42		Logical versus Physical Address Space	L3:Analyze	**T1**
43		Swapping	L3:Analyze	
44		Tutorial / Bridge Class #5	L3:Analyze	
45		Contiguous Allocation	L3:Analyze	
46	**IV**	Paging	L3:Analyze	
47		Tutorial / Bridge Class #4	L2:Understand	
48		Paging	L3:Analyze	
49		Segmentation	L3:Analyze	**T1**
50		Segmentation with Paging	L3:Analyze	
51		Demand Paging	L3:Analyze	
52		Page Replacement Introduction	L3:Analyze	
53	**IV**	Disk Structure	L3:Analyze	**T1**
54		Page Replacement Algorithms.	L3:Analyze	
55		Page Replacement Algorithms.	L3:Analyze	

56		Page Replacement Algorithms.	L3:Analyze	
57	V	File System Interface and Operations	L3:Analyze	T2
58		Access methods	L3:Analyze	
59		Directory Structure	L3:Analyze	
60		Protection	L3:Analyze	
61		Tutorial / Bridge Class #5	L3:Analyze	T2
62		File System Structure	L3:Analyze	
63		Allocation methods	L3:Analyze	
64		Free-space Management.	L3:Analyze	
65		Free-space Management.	L3:Analyze	
66		Tutorial / Bridge Class #6	L3:Analyze	
67		Usage of open, create, read, write system calls	L3:Analyze	
68		Usage of open, create, read, write system calls	L3:Analyze	
69		Usage of close, lseek, stat, ioctl system calls	L3:Analyze	
70		Revision	L3:Analyze	

Mapping Course Outcomes Leading to the Achievement of Program Outcomes and Program Specific Outcomes:

Course Outcomes	Program Outcomes (PO)												Program Specific Outcomes (PSO)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	3	3	-	-	-	-	-	-	-	-	-	2	-	2
CO2	1	2	2	-	-	-	-	-	-	-	-	-	1	-	-
CO3	3	2	1	-	-	-	-	-	-	-	-	-	1	2	2
CO4	2	1	3	-	-	-	-	-	-	-	-	-	1	-	-
CO5	1	1	1	-	-	-	-	-	-	-	-	-	1	1	2

Descriptive Questions

UNIT– I

Short answer questions

1	Define operating system?	[UNDRESTANDING]
2	List the advantages of multiprogramming?	[REMEMBERING]
3	Define virtual machine?	[UNDRESTANDING]
4	Define multiprocessor system?	[UNDRESTANDING]
5	Define kernel?	[UNDRESTANDING]

Long answer questions

1	State and explain various types of computer systems	[REMEMBERING]
2	Explain how protection is provided for the hardware resources by the operating system?	[UNDRESTANDING]
3	Describe the operating system structures?	[CREATING]
4	Discuss the view of an operating system as a resource manager?	[CREATING]
5	Explain how operating system services are provided by system calls	[UNDRESTANDING]

UNIT– II

Short answer questions

1	Define process. What is the information maintained in a PCB?	[UNDRESTANDING]
2	Explain the use of job queues, ready queues and device queues?	[UNDRESTANDING]
3	Define CPU scheduling?	[UNDRESTANDING]
4	Define Multi processor scheduling?	[UNDRESTANDING]
5	Describe system calls?	[CREATING]

Long answer questions

1	Explain the process state transition diagram with examples	[UNDRESTANDING]
2	Explain the principles of concurrency and the execution of concurrent processes with a simple example?	[UNDRESTANDING]
3	Explain system calls for process management?	[UNDRESTANDING]
4	List out the various process states and briefly explain the same with a state diagram?	[UNDRESTANDING]
5	A scheduling mechanism should consider various scheduling criteria to realize the scheduling objectives? List out all the criteria.	[CREATING]

UNIT– III

Short answer questions

1	Describe the representation of a resource-allocation graph?	[CREATING]
2	Describe the purpose of banker's algorithm?	[CREATING]
3	Describe the purpose of banker's algorithm?	[CREATING]
4	Describe the techniques for recovery from deadlock?	[CREATING]
5	Describe role-based access control?	[CREATING]
6	Define the terms – object, domain, access right?	[UNDRESTANDING]

7	Define race condition?	[UNDRESTANDING]
8	Describe entry and exit sections of a critical section?	[CREATING]
9	Explain IPC	[UNDRESTANDING]
10	Explain pipes, fifos	[UNDRESTANDING]

Long answer questions

1	Explain briefly resource allocation graph with examples?	[UNDRESTANDING]
2	Discuss deadlock detection method in detail?	[CREATING]
3	Describe how the access matrix facility and role-based access control facility are similar? How do they differ?	[CREATING]
4	Describe how the access matrix facility and role-based access control facility are similar? How do they differ?	[CREATING]
5	Discuss the access matrix implementation techniques?	[CREATING]
6	Explain various schemes to implement revocation for capabilities?	[UNDRESTANDING]
7	Explain the infinite buffer producer/consumer problem for concurrent processing which uses binary semaphores	[UNDRESTANDING]
8	Discuss IPC with pipes, fifos ,message queues, shared memory	[CREATING]
9	Explain classical synchronization problems	[UNDRESTANDING]

UNIT– IV

Short answer questions

1	Explain the main function of the memory-management unit?	[UNDRESTANDING]
2	Define swapping?	[UNDRESTANDING]
3	Distinguish between MFT and MVT?	[ANALYZE]
4	List and define non-contiguous memory allocation schemes?	[REMEMBERING]
5	Distinguish between demand paging and pure demand paging?	[ANALYZE]

Long answer questions

1	Explain in detail the requirements that memory management technique needs to satisfy?	[UNDRESTANDING]
2	Discuss briefly the swapping concept with necessary examples?	[CREATING]
3	Explain briefly about paging with neat diagram?	[UNDRESTANDING]
4	Explain the basic concepts of segmentation with neat diagrams?	[UNDRESTANDING]
5	State and explain about virtual memory concept with neat diagram?	[REMEMBER]

Objective Questions

UNIT– I

1. CPU fetches the instruction from memory according to the value of
   a) program counter b) status register
   c) instruction register d) program status word
2. A memory buffer used to accommodate a speed differential is called
   a) stack pointer b) cache c) accumulator d) disk buffer
3. Which one of the following is the address generated by CPU?
   a) physical address b) absolute address
   c) logical address d) none of the mentioned
4. Run time mapping from virtual to physical address is done by
   a) memory management unit b) CPU

c) PCI d) none of the mentioned

5. The address of a page table in memory is pointed by
   a) stack pointer b) page table base register
   c) page register d) program counter

Answers

1.A 2.B 3.C 4.A 5.B

Fill in the blanks

1. Is known as a main memory.(RAM)
2. A memory that requires refreshing of data is ---------- (Dynamic Ram)
3. Cache memory is used in a computer system to---------- (Speed up memory Access)
4. Program which acts as a interface between a user and the hardware is called ----------(Operating system)
5. Is a program that translates mnemonic statements into executable instructions.(Assembler)

UNIT– II

1) A process includes
   a) Program counter b) Stack Data c)set d)All the above

2) In the following which is not a state of process
   a) New b) Ready c) running d)interrupt
3) ___is not a process scheduling queue
   a)Job queue b) Ready queue c) Schedule queue d) Device queue
4) CPU scheduler decisions may take place when a process
   a)Switch from running to wait stage b) Switch from running to ready state
   c) Switch from waiting to ready state d) Terminate e) All the above
5) The LRU algorithm
   a) Pages out pages that have been used recently
   b) Pages out pages that have not been used recently
   c) Pages out pages that have been least used recently
   d) None of the above

Answers

1) d, 2) d 3) c 4) e 5) c

Fill in the blanks

1) A process is a_____(program in execution)
2) Long term scheduler is also called as_____(job scheduler)
3) Process that complete their execution per time unit is called_____(throughput)
4) Homogeneous processes is within a_____(multi processor)
5) Two or more processes are waiting for a event is called_____(dead lock)

UNIT– III

1) The wait-for graph is a deadlock detection algorithm that is applicable when :
   a) all resources have a single instance
   b) all resources have multiple instances
   c) both a and b
   d) None of the above

2) The disadvantage of invoking the detection algorithm for every request is :
a) overhead of the detection algorithm due to consumption of memory
b) excessive time consumed in the request to be allocated memory
c) considerable overhead in computation time
d) All of these

3) Every time a request for allocation cannot be granted immediately, the detection algorithm is invoked. This will help identify : (choose all that apply)
a) the set of processes that have been deadlocked
b) the set of processes in the deadlock queue
c) the specific process that caused the deadlock
d) All of these

4) A system has 3 processes sharing 4 resources. If each process needs a maximum of 2 units then, deadlock :
a) can never occur b) may occur c) has to occur d) None of these

5) m' processes share 'n' resources of the same type. The maximum need of each process doesn't exceed 'n' and the sum of all their maximum needs is always less than m+n. In this setup, deadlock :
a) can never occur b) may occur c) has to occur d) None of these

Answers

1)a 2)c 3) a and c 4)a 5)a

Fill in the blanks

1) If deadlocks occur frequently, the detection algorithm must be invoked_____.(frequently)
2) _____Principle states that programs, users and even the systems be given just enough privileges to perform their task(principle of least privilege)
3) If the set of resources available to the process is fixed throughout the process's lifetime then its domain is(static)
4) In I/O protection I/O must be performed via_____(system calls)
5) DMA controller Bypasses CPU to transfer data directly between I/O device and_____(memory)

UNI – IV

1) Data cannot be written to secondary storage unless written within a_____.
a) file b) swap space c) directory d) text format

2) The information about all files is kept in :
a) swap space b) operating system c) separate directory structure
d) None of these

3) The open file table has a/an_____associated with each file.
a) file content b) file permission c) open count d) close count

4) 4) Sequential access method_____, on random access devices.
a) works well b) doesn't work well c) Both a and b d) None of these

5) For a direct access file :
a) there are restrictions on the order of reading and writing
b) there are no restrictions on the order of reading and writing
c) access is restricted permission wise
d) access is not restricted permission wise

Answers

1)a 2)c 3)c 4)a 5)b

Fill in the blanks

1) The larger the block size, the_____the internal fragmentation.(greater)
2) The direct access method is based on a_____model of a file, as_____allow random access to any file block.(disk , disks)
3) An unrecoverable error is known as_____.(hard error)
4) Using swap space significantly_____system performance.(decreases)
5) It is_____to reread a page from the file system than to write it to swap space and then to reread it from there.(more efficient)

UNIT– V

1) Physical memory is broken into fixed-sized blocks called_____.
a) Frames b) pages c) backing store d) none of these
2) In segmentation, each address is specified by :
a) a segment number b) an offset c) a value d) a key
3) Every address generated by the CPU is divided into two parts : (choose two)
a) Frame bit b) Page number c) Page offset d) Frame offset
4) The_____is used as an index into the page table.
a) frame bit b) page number c) page offset d) frame offset
5) The_____table contains the base address of each page in physical memory.
a) Process b) memory c) page d) frame

Answers

1) a 2) a and b 3) b and c 4) b 5) c

Fill in the blanks

1) With paging there is no_____fragmentation.(external)
2) Paging increases the__time.(context – switch)
3) Each entry in a segment table has a :_and___(segment base, segment limit)
4) The segment limit contains__(segment length)
5) Time taken in memory access through PTBR is____(slowed by a factor of 2)

List Of Topics For Students' Seminars

1. CPU Scheduling.
2. Synchronization
3. Memory Scheduling.
4. Disk Scheduling.
5. File Systems.
6. Inter Process Communication.

Operating Systems Notes Link

- **https://drive.google.com/drive/folders/14x-tuhhxT2Wwmwc5ZHXXeQmj-wuQ7W9W?usp=sharing**