CMR ENGINEERING COLLEGE

UGC AUTONOMOUS

(Approved by AICTE - New Delhi. Affiliated to JNTUH and Accredited by NAAC & NBA)

COURSE INSTRUCTOR NAME: Ms.D.NAVANITHA ACADEMIC YEAR:2023-24

SUBJECT NAME:OPERATING SYSTEMS

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SEM START DATE AND END DATE: 18-9-23 T0 20-01-24

CONTENTS OF COURSE FILE

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HOD

1. DEPARTMENT VISION & MISSION

VISION:

To produce globally competent and industry-ready graduates in Computer Science & Engineering by imparting quality education with the know-how of cutting-edge technology and holistic personality.

MISSION:

1. To offer high-quality education in Computer Science & Engineering in order to build core competence for the graduates by laying a solid foundation in Applied Mathematics and program frameworkwith a focus on concept building.
2. The department promotes excellence in teaching, research, and collaborative activities to prepare graduates for a professional career or higher studies.
3. Creating an intellectual environment for developing logical skills and problem-solving strategies, thus developing, an able and proficient computer engineer to compete in the current global scenario.

2. LIST OF PEOs, POs AND PSOs

2.1 Program Educational Objectives (PEO):

PEO 1: Excel in professional career and higher education by acquiring knowledge of mathematical computing and engineering principles.
PEO 2: To provide an intellectual environment for analyzing and designing computing systems for technical needs.
PEO 3: Exhibit professionalism to adapt current trends using lifelong learning with legal and ethical responsibilities.
PEO 4: To produce responsible graduates with effective communication skills and multidisciplinary practices to serve society and preserve the environment.

2.2. Program Outcomes (POs):

Engineering Graduates will be able to satisfy these NBA graduate attributes:

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, review 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 practice.

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.

2.3 Program Specific Outcomes (PSOs):

PSO1: Professional Skills and Foundations of Software development: Ability to analyze, design and develop applications by adopting the dynamic nature of Software developments.
PSO2: Applications of Computing and Research Ability: Ability to use knowledge in cutting edge technologies in identifying research gaps and to render solutions with innovative ideas.

3. COURSE OUTCOMES

CO1	Students will be able to **define** the operating systems concepts, types of operating systems, system calls, process, and threads concepts.**[BTL1][REMEMBERING]**
CO2	Will be able to and be able to **classify** CPU scheduling algorithms and **interpret** the Deadlock handling methods.**[BTL2,5][UNDERSTANDING,EVALUATING]**
CO3	Memorize the process management and synchronization approaches, and **summarize** the IPC mechanisms. **[BTL2][UNDERSTANDING]**
CO4	**Illustrate** Memory management techniques and virtual memory such as Paging, Segmentation, Demand, Paging, and Page Replacement Algorithms.**[BTL2][UNDERSTANDING]**
CO5	Recite the file system interfaces/structure and **describe** the disk management techniques/system calls.**[BTL1][KNOWLEDGE]**
PSO1	**Professional Skills and Foundations of Software development**: Ability to analyze, design, and develop applications by adopting the dynamic nature of Software development.
PSO2	**Applications of Computing and Research Ability**: Ability to use knowledge in cutting-edge technologies in identifying research gaps and to render cutting-edge innovative ideas.

REVISED Bloom's Taxonomy Action Verbs

Definitions	I. Remembering	II. Understanding	III. Applying	IV. Analyzing	V. Evaluating	VI. Creating
Bloom's Definition	Exhibit memory of previously learned material by recalling facts, terms, basic concepts, and answers.	Demonstrate understanding of facts and ideas by organizing, comparing, translating, interpreting, giving descriptions, and stating main ideas.	Solve problems to new situations by applying acquired knowledge, facts, techniques and rules in a different way.	Examine and break information into parts by identifying motives or causes. Make inferences and find evidence to support generalizations.	Present and defend opinions by making judgments about information, validity of ideas, or quality of work based on a set of criteria.	Compile information together in a different way by combining elements in a new pattern or proposing alternative solutions.
Verbs	• Choose • Define • Find • How • Label • List • Match • Name • Omit • Recall • Relate • Select • Show • Spell • Tell • What • When • Where • Which • Who • Why	• Classify • Compare • Contrast • Demonstrate • Explain • Extend • Illustrate • Infer • Interpret • Outline • Relate • Rephrase • Show • Summarize • Translate	• Apply • Build • Choose • Construct • Develop • Experiment with • Identify • Interview • Make use of • Model • Organize • Plan • Select • Solve • Utilize	• Analyze • Assume • Categorize • Classify • Compare • Conclusion • Contrast • Discover • Dissect • Distinguish • Divide • Examine • Function • Inference • Inspect • List • Motive • Relationships • Simplify • Survey • Take part in • Test for • Theme	• Agree • Appraise • Assess • Award • Choose • Compare • Conclude • Criteria • Criticize • Decide • Deduct • Defend • Determine • Disprove • Estimate • Evaluate • Explain • Importance • Influence • Interpret • Judge • Justify • Mark • Measure • Opinion • Perceive • Prioritize • Prove • Rate • Recommend • Rule on • Select • Support • Value	• Adapt • Build • Change • Choose • Combine • Compile • Compose • Construct • Create • Delete • Design • Develop • Discuss • Elaborate • Estimate • Formulate • Happen • Imagine • Improve • Invent • Make up • Maximize • Minimize • Modify • Original • Originate • Plan • Predict • Propose • Solution • Solve • Suppose • Test • Theory

Anderson, L. W., & Krathwohl, D. R. (2001). A taxonomy for learning, teaching, and assessing, Abridged Edition. Boston, MA: Allyn and Bacon.

Action Words for Bloom's Taxonomy					
Knowledge	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Create**
define	explain	solve	analyze	reframe	design
identify	describe	apply	compare	criticize	compose
describe	interpret	illustrate	classify	evaluate	create
label	paraphrase	modify	contrast	order	plan
list	summarize	use	distinguish	appraise	combine
name	classify	calculate	infer	judge	formulate
state	compare	change	separate	support	invent
match	differentiate	choose	explain	compare	hypothesize
recognize	discuss	demonstrate	select	decide	substitute
select	distinguish	discover	categorize	discriminate	write
examine	extend	experiment	connect	recommend	compile
locate	predict	relate	differentiate	summarize	construct
memorize	associate	show	discriminate	assess	develop
quote	contrast	sketch	divide	choose	generalize
recall	convert	complete	order	convince	integrate
reproduce	demonstrate	construct	point out	defend	modify
tabulate	estimate	dramatize	prioritize	estimate	organize
tell	express	interpret	subdivide	find errors	prepare
copy	identify	manipulate	survey	grade	produce
discover	indicate	paint	advertise	measure	rearrange
duplicate	infer	prepare	appraise	predict	rewrite
enumerate	relate	produce	break down	rank	role-play
listen	restate	report	calculate	score	adapt
observe	select	teach	conclude	select	anticipate
omit	translate	act	correlate	test	arrange
read	ask	administer	criticize	argue	assemble
recite	cite	articulate	deduce	conclude	choose
record	discover	chart	devise	consider	collaborate
repeat	generalize	collect	diagram	critique	collect
retell	give examples	compute	dissect	debate	devise
visualize	group	determine	estimate	distinguish	express
	illustrate	develop	evaluate	editorialize	facilitate
	judge	employ	experiment	justify	imagine
	observe	establish	focus	persuade	infer
	order	examine	illustrate	rate	intervene
	report	explain	organize	weigh	justify
	represent	interview	outline		make
	research	judge	plan		manage
	review	list	question		negotiate
	rewrite	operate	test		originate
	show	practice			propose
	trace	predict			reorganize
	transform	record			report
		schedule			revise
		simulate			schematize
		transfer			simulate
		write			solve
					speculate
					structure
					support
					test
					validate

Center for University Teaching, Learning, and Assessment http://uwf.edu/cutla/SLO/ActionWords.pdf

4. SYLLABUS COPY

UNIT-I

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

Process and CPU scheduling - process concepts and scheduling, operations on processes, cooperating processes, threads.

UNIT–II

CPU Scheduling-Scheduling criteria, scheduling algorithms, multiple -processor scheduling. System call interface for process management-fork, exit, wait, waitpid, exec

Deadlocks - system model, deadlocks characterization, methods for handling deadlocks, deadlock prevention, deadlock avoidance, deadlock detection, and recovery from deadlock

UNIT–III

Process management and synchronization - the critical section problem, synchronization hardware, semaphores, and classical problems of synchronization, critical regions, monitors

Interprocess 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, JohnWiley

2. Advanced programming in the UNIX environment, W.R. Stevens, Pearson education.

REFERENCE BOOKS:

R1- Operating Systems – Internals and Design Principles Stallings, Fifth Edition–2005, Pearson Education/PHI

R2- Operating System A Design Approach- Crowley,TMH.

R3- Modern Operating Systems, Andrew S. Tanenbaum 2nd edition,Pearson/PHI

R4- UNIX programming environment, Kernighan and Pike, PHI/ PearsonEducation

R5- UNIX Internals -The New Frontiers, U. Vahalia, PearsonEducation.

5. INDIVIDUAL TIME TABLE(D.NAVANITHA)

	I	II	III	IV		V	VI	VII
MON	OS II-C				L U N C H	OS II-A		
TUE								OS II-C
WED		OS LAB-II C					OS II-C	
THU			OS II-A				OS II-A	OS II-C
FRI	OS II-A		OS II-C			OS II-A		
SAT				OS II-A		OS LAB-II C		

6. SESSION PLAN/LESSON PLAN

S.NO	Topic (JNTU syllabus)	Sub-Topic	NO. OF LECTURES REQUIRED	Suggested Books	Teaching Methods
UNIT – I					
1	**Operating System - Introduction**	Introduction, Structures	**L1**	**T1**	**M1**
2		Simple Batch, Multi-programmed	**L2**	**T1**	**M1**
3		Time-shared, Personal Computer	**L3**	**T1**	**M1**
4		Parallel, Distributed Systems,	**L4**	**T1**	**M1**
5		Real-Time Systems	**L5**	**T1**	**M1**
6		System components	**L6**	**T1**	**M1**
7		Operating System services	**L7**	**T1**	**M1**
8		System Calls	**L8**	**T1**	**M1**
9	**Process Concepts**	Process concepts and Scheduling	**L9**	**T1**	**M1**
10		Operations on processes	**L10**	**T1**	**M1**
11		Cooperating Processes	**L11**	**T1**	**M1**
12		Threads	**L12**	**T1**	**M1**
13		**UNIT-I**	**L13**	**SLIP TEST**	
UNIT – II					
14	**Process and CPU Scheduling**	Scheduling Criteria	**L14**	**T1**	**M1**
15		Scheduling Algorithms	**L15, L16, L17,L18,**	**T1**	**M1**
16		Multiple -Processor Scheduling	**L19, L20**	**T1**	**M1**

17		System call interface for process management-fork, exit, wait, waitpid, exec	**L21**	**T1**	**M1**
18	**Deadlocks**	System Model, Deadlocks Characterization	**L22,L23**	**T1**	**M1**
19		Methods for Handling Deadlocks	**L24**	**T1**	**M1**
20		Deadlock Prevention, Deadlock Avoidance	**L25, L26**	**T1**	**M1**
21		Deadlock Detection, and Recovery from Deadlock	**L27,L28**	**T1**	**M1**
22		**UNIT-II**	**L29**	**SLIP TEST**	
UNIT-III					
23	**Process management and synchronization**	The Critical Section Problem	**L30**	**T1**	**M1**
24		Synchronization hardware	**L31**	**T1**	**M1**
25		Semaphores, Classical Problems of Synchronization	**L32,L33,L34**	**T1**	**M1**
26		Critical Regions, Monitors	**L35,L36**	**T1**	**M1**
27	**Interprocess communication mechanisms**	IPC between processes on a single computer system.	**L37**	**T1**	**M1**
28		IPC between processes on different systems, using pipes	**L38**	**T1**	**M1**
29		FIFOs, message queues, shared memory	**L39**	**T1**	**M1**
30		**UNIT-III**	**SLIP TEST**		
UNIT-IV					
31	**Memory Management and Virtual Memory**	Logical versus Physical Address Space, Swapping	**L39**	**T1**	**M4(PPT)**
32		Contiguous Allocation, Paging	**L40, L41**	**T1**	**M4(PPT)**

33		Segmentation, Segmentation with Paging	**L42, L43**	**T1**	**M4(PPT)**
34		Demand Paging	**L44**	**T1**	**M4(PPT)**
35		Page Replacement	**L45**	**T1**	**M4(PPT)**
36		Page Replacement Algorithms	**L46,L47**	**T1**	**M4(PPT)**
UNIT - V					
37	**File System Interface and Operations**	Access methods, Directory Structure	**L48**	**T1**	**M4(PPT)**
38		Protection, File System Structure	**L49,L50**	**T1**	**M4(PPT)**
39		Allocation methods	**L51**	**T1**	**M4(PPT)**
40		Free-space Management	**L52**	**T1**	**M4(PPT)**
41		Usage of open, create, read, write	**L53**	**T1**	**M4(PPT)**
42		close, lseek, stat, ioctl system calls.	**L54**	**T1**	**M4(PPT)**
Total			**54**		

METHODS OF TEACHING:

M1 : Lecture Method	**M4 : Presentation /PPT**	**M7 : Assignment**
M2 : DemoMethod	**M5 : Lab/Practical**	**M8 : Industry Visit**
M3 : Guest Lecture	**M6 : Tutorial**	**M9 : Project Based**

NOTE:

1. AnySubjectinaSemesterissupposetobecompletedin55to65periods.
2. Each Period is of 50minutes.
3. Each unit duration &completion should be mentioned in the Remarks Coloumn.
4. ListofSuggestedbookscanbemarkedwithCodeslikeT1,T2,R1,R2etc.

7. Session Execution Log:

S. no	Unit	Scheduled completed date	Completed date	Remarks
1	I	20-09-2023	11-10-2023	COMPLETED
2	II	13-10-2023	10-11-2023	COMPLETED
3	III	11-11-20223	15-12-2023	COMPLETED
4	IV	16-12-2023	3-01-2024	COMPLETED
5	V	4-01-2024	20-01-2024	COMPLETED

8. Lecture Notes – (hand written)

9.ASSIGNMENT QUESTIONS ALONG WITH SAMPLE ASSIGNMENT SCRIPTS

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MID 1 ASSIGNMENT

ACADEMIC YEAR 2023-24

SUBJECT NAME: OPERATING SYSTEMS

1. a)**Explain** the various system calls used in OS with examples. **(CO1)**
   b)**Discuss** the Functionalities of Operating Systems in detail. **(CO1)**
2. a) **Explain** the banker's algorithm for deadlock avoidance. **(CO2)**

A (10 instances), *B* (5instances), and *C* (7 instances)
Snapshot at time T_0:

	Allocation	Max	Available
	A B C	A B C	A B C
P_0	0 1 0	7 5 3	3 3 2
P_1	2 0 0	3 2 2	
P_2	3 0 2	9 0 2	
P_3	2 1 1	2 2 2	
P_4	0 0 2	4 3 3	

b) **What** is Deadlock? **List** the condition that leads to deadlock. **How** deadlock can be prevented. **(CO2)**

3. a) **Discuss** Synchronization. Briefly **explain** the types of Synchronization. **(CO3)**
   b) **What** are the criteria for evaluating the CPU scheduling algorithm? **(CO2)**
4. a) **What** is the critical section to **solve** the critical section problem? **(CO3)**
   b) Consider the following set of processes, with the length of the CPU burst given in milliseconds: **(CO2)**

Process	Burst Time	Priority
P1	27	5
P2	12	1
P3	37	2
P4	19	4
P5	10	3

5. a) **Explain** the methods for handling deadlocks. **(CO2)**
   b) **What** are the various components of operating system structure and **explain** with a neat sketch. **(CO1)**

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MID II ASSIGNMENT

ACADEMIC YEAR 2023-24

SUBJECT NAME: OPERATING SYSTEMS

1. a) **What** is process synchronization? **How** is it achieved using software and hardware?**(CO3)**
   b) **What** is the reader-writer's problem? **Explain** its solution with semaphore. **(CO3)**
2. **Explain** the solution for Critical Section Problem. **(CO3)**
3. a)**Discuss** the concept of a named pipe (FIFO) and its usage in IPC. **(CO3)**

b) **Explain** the swapping in memory management.**(CO4)**

4. Consider the following page reference string: 7,0,1,2,0,3,0,4,2,3,0,3,0,3,2,1,2,0,1,7,0,1.**How** many page faults would occur for the LRU and Optimal page replacement algorithms, assuming three frames and all frames are initially free.**(CO4)**

5. a)**What** is demand paging? **Explain** Paging and segmentation in detail.**(CO4)**
b)**Elaborate** about free space management.**(CO5)**

10.Mid exam question papers along with sample answer scripts

MID-1

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Kandlakoya (V), Medchal (M), Medchal - Malkajgiri (D)-501401

II-B.TECH(R-22) I-SEM I-MID EXAMINATIONS, NOVEMBER 2023
SUBJECT: OPERATING SYSTEMS

BRANCH:CSE,CSM, CSD,CS, IT MARKS:30 M
DATE: 23-11-2023 TIME: 10 AM to 12:00 PM
Answer all questions in Part-A &Answer any FOUR question in Part-B

Part-A **5*2=10M**

	BTL	CO
Q1.**What** is an operating system? Give examples.	1	**[CO1]**
Q2. **Write** short note on Real Time Operating Systems.	6	**[CO1]**
Q3. **Discuss** about the CPU Scheduling types**.**	6	**[CO2]**
Q4. **Explain**about fork( ) and wait( ) system call.	1	**[CO2]**
Q5.**Define** critical-section problem.	1	**[CO3]**

Answer any four questions

Part-B **4*5=20M**

Q6. **What** is a System call? **Discuss** major System calls of Operating Systems. 1,6 **[CO1]**

Q7. a) **Explain** about the distributed operating system in brief. 5 **[CO1]**

b) **Distinguish** between Multi Programming, Multi Tasking and Multi processing systems. 4 **[CO1]**

Q8. Consider the following set of processes, with the length of the CPU burst given in milliseconds:

Process	Burst Time	Priority
P1	27	5
P2	12	1

P3	37	2
P4	19	4
P5	10	3

The processes are assumed to have arrived in the order P1, P2, P3, P4, P5 all at time 0. Draw the Gantt charts that **illustrate** the execution of these processes using the following scheduling algorithms: FCFS and Priority. Also **determine** the average waiting time and average turnaround time for each of the algorithms. 2, 5 **[CO2]**

Q9. **What** is Deadlock? **List** the condition that leads to deadlock. **How** deadlock can be prevented. 1 **[CO2]**

Q10.**What** is Scheduler? **Explain** the queuing diagram representation of the process scheduler with neat **sketch**. 1, 5 **[CO2]**

Q11. **Define** Synchronization. Briefly **explain** the types of Synchronization. 1, 5 **[CO3]**

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II-B.TECH(R-22) I-SEM I-MIDEXAMINATIONS, NOVEMBER 2023
SUBJECT: OPERATING SYSTEMS

BRANCH:CSE,CSM, CSD,CS, IT MARKS:30 M
DATE: 23-11-2023 TIME: 10 AM to 12:00 PM

Answer all questions in Part-A &Answer any FOUR question in Part-B

Part-A **5*2=10M**

	BTL	CO
Q1. **What** is thread? **List** out the types of threads.	1	**[CO1]**
Q2. **Define** context switching.	1	**[CO2]**
Q3. **Write** about fork() and wait() system calls.	6	**[CO2]**
Q4**. What** is deadlock prevention?	1	**[CO2]**
Q5. **Discuss** the types of Synchronization.	6	**[CO3]**

Answer any four questions

Part-B **4*5=20**

Q6 **Discuss** the Functionalities of Operating Systems in detail 6 **[CO1]**

Q7. **What** are the various components of operating system structure and **explain** with a neat sketch. 1,5 **[CO1]**

Q8. **Explain** about the banker's algorithm for deadlock avoidance. 5 **[CO2]**

A (10 instances), *B* (5instances), and *C* (7 instances)

Snapshot at time T_0:

	Allocation	Max	Available
	A B C	*A B C*	*A B C*
P_0	0 1 0	7 5 3	3 3 2
P_1	2 0 0	3 2 2	
P_2	3 0 2	9 0 2	
P_3	2 1 1	2 2 2	
P_4	0 0 2	4 3 3	

Q9. **What** are the criteria for evaluating the CPU scheduling algorithm 1 **[CO2]**

Q10. Consider Five processes P1 to P5 arrived at same time. They have estimated running time 10,2,6,8 and 4 seconds respectively. Their priorities are 3,2,5,4 and 1 respectively with 5 being highest priority. **Find** the average turnaround time and average waiting time for Round Robin(q=3) and priority scheduling algorithm 1 **[CO2]**

Q11. **What** is the critical section to solve the critical section problem? 1 **[CO3]**

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II-B.TECH(R-22) I-SEM I-MID EXAMINATIONS, NOVEMBER 2023
SUBJECT: OPERATING SYSTEMS

BRANCH:CSE,CSM, CSD,CS, IT MARKS:30 M
DATE: 23-11-2023 TIME: 10 AM to 12:00 PM

Answer all questions in Part-A &Answer any FOUR question in Part-B

Part-A **5*2=10M**

	BTL	CO
Q1. **Define** Multi Programming and Time Sharing.	1	**[CO1]**
Q2. **What** is a distributed system? Give an example?	1	**[CO1]**
Q3. **Define** the Process states.	1	**[CO2]**
Q4. **Explain** about SJF.	5	**[CO2]**
Q5. **Write** about Process Management.	6	**[CO3]**

Answer any four questions

Part-B **4*5=20**

Q6 **Explain** the various system calls used in OS with examples.	5	**[CO1]**
Q7. **Explain** the banker's algorithm for deadlock avoidance.	5	**[CO2]**

A (10 instances), *B* (5instances), and *C* (7 instances)
Snapshot at time T_0:

	Allocation	Max	Available
	A B C	A B C	A B C
P_0	0 1 0	7 5 3	3 3 2
P_1	2 0 0	3 2 2	
P_2	3 0 2	9 0 2	
P_3	2 1 1	2 2 2	
P_4	0 0 2	4 3 3	

Q8. **Describe** the Round Robin scheduling algorithm. **Illustrate** with an example. 1,4 **[CO2]**

Q9. **Explain** the methods for handling deadlocks 5 **[CO2]**

Q10. **Describe** the following scheduling algorithms.

a) Priority b) FCFS 1 **[CO2]**

Q11. **What** is the critical section to solve the critical section problem? 1 **[CO3]**

MID-2

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Kandlakoya (V), Medchal (M), Medchal - Malkajgiri (D)-501401

II-B.TECH(R-22) I-SEM II-MID EXAMINATIONS, JANUARY 2024

SUBJECT: OPERATING SYSTEMS

BRANCH: CSE,CSM, CSD,CS, IT MARKS:30 M

Date: 24/1/2024 Time:1:30PM to 3:30 PM

Answer all questions in Part-A

Part-A	**BTL**	**CO**
Q1. **Define** Virtual memory.	**1**	**[CO4]**
Q2. **What** is File sharing?	**1**	**[CO5]**
Q3. **Explain** aboutlanguage based protection.	**2**	**[CO5]**
Q4. **How** does the segmentation differ from paging?	**1**	**[CO4]**
Q5. **What** is meant by monitors?	**1**	**[CO3]**

Answer any four questions

Part-B **4*5=20**

Q6.Forthe following page reference string 7,0,1,2,0,3,0,4,2,3,0,3,2,1,2,0,1,7,0,1. Calculate the page faults **applying** the following Page replacement algorithms for memory with three frames:

a) LRU

b) FIFO **3** **[CO4]**

Q7.**What** is a Semaphore? Give the implementation of the Bounded Buffer Producer-Consumer Problem using Semaphore. **1 [CO3]**

Q8. **Explain** about domain protection mechanism in brief. **2 [CO5]**

Q9.**Describe**the different types of File allocation methods. **1 [CO5]**

Q10.**What** is Mutual exclusion? **Explain** Peterson's solution for the mutual exclusion problem.**1,2[CO3]**

Q11. a)**Distinguish** betweenthe Logical and Physical Address Space.**4 [CO4]**

b) **List** the advantages and disadvantages of Demand Paging. **1 [CO4]**

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II-B.TECH(R-22) I-SEM II-MID EXAMINATIONS, JANUARY 2024

SUBJECT: OPERATING SYSTEMS

BRANCH: CSE, CSM, CSD,CS, IT **MARKS:30 M**

Date: 24/1/2024 Time: 1:30PM to 3:30 PM

Answer all questions in Part-A

Part-A	**BTL**	**CO**
Q1. **How** does the process communicate in inter-process communication?	**1**	**[CO3]**
Q2. **Define** demand paging.	**1**	**[CO4]**
Q3. **Write** about the page replacement algorithm.	**6**	**[CO4]**
Q4**. List** out theFile types.	**1**	**[CO5]**
Q5. **What** is meant by pipe? **List** the types of pipes.	**1**	**[CO3]**

Answer any four questions

Part-B **4*5=20**

Q6.**Discuss** the concept of a named pipe (FIFO) and its usage in IPC. **6 [CO3]**

Q7.Consider the following page reference string: 7,0,1,2,0,3,0,4,2,3,0,3,0,3,2,1,2,0,1,7,0,1. **How**many page faults would occur for the LRU and Optimal page replacement algorithms, assuming three frames and all frames are initially free? **1 [CO4]**

Q8. a)**Discuss** in detail about different file access methods. **6 [CO5]**

b) Briefly **explain** the directory organization. **2 [CO5]**

Q9. **What** is the reader-writer's problem? **Explain** its solution with semaphore. **1,2 [CO3]**

Q10.**Explain** about performance of demand paging and pure demand paging? **2 [CO4]**

Q11. **Describe** the advantages of Contiguous allocation and drawbacks of contiguous allocation of disk space. **1 [CO4]**

II-B.TECH(R-22) I-SEM II-MID EXAMINATIONS, JANUARY 2024

SUBJECT: OPERATING SYSTEMS

BRANCH: CSE,CSM, CSD,CS, IT MARKS:30 M

Date: 24/1/2024 Time:1:30PM to 3:30 PM

Answer all questions in Part-A

Part-A	**BTL**	**CO**
Q1. **What** is a message queue?	**1**	**[CO3]**
Q2.Briefly**explain** page fault andpage fault ratio?	**2**	**[CO4]**
Q3. **List** out various file attributes.	**1**	**[CO5]**
Q4. **Write** about read( ),write( ),truncate( ),seek( ) system calls.	**6**	**[CO5]**
Q5. **Define** internal and external fragmentation.	**1**	**[CO4]**

Answer anyfour questions

Part-B **4*5=20**

Q6. For the following page reference string 7,0,1,2,0,3,0,4,2,3,0,3,2,1,2,0,1,7,0,1. Calculate the page faults by **applying** the following Page replacement algorithms for memory with three frames:

a) LRU b) FIFO **3 [CO4]**

Q7. **What** is Demand paging? **Explain** the working of demand paging and also give the advantages and disadvantages of Demand Paging. **1,2 [CO4]**

Q8. **Explain** the file system structure. **2 [CO5]**

Q9. **Discuss** about resuming processes within a Monitor. **6 [CO3]**

Q10. **How** to **Solve** Dining Philosopher's Problem Using Monitors? **1,6 [CO3]**

Q11. **Explain** the following: **2 [CO5]**

a) Virtual file systems

b) Indexed allocation

11. SCHEME OF EVALUATION

Mid-1

S.NO	THEORY	MARKS	TOTAL
1	**What** is an operating system? Give examples.	2	10
2	**Write** short note on Real Time Operating Systems.	2	
3	**Discuss** about the CPU Scheduling types.	2	
4	**Explain** about fork( ) and wait( ) system call.	2	
5	**Define** critical-section problem.	2	
6	**Part-B** **What** is a System call? **Discuss** major System calls of Operating Systems.	5	
7	a) **Explain** about the distributed operating system in brief. **b) Distinguish** between Multi Programming, Multi Tasking and Multi processing systems.	5	

8	Consider the following set of processes, with the length of the CPU burst given in milliseconds: Process Burst Time Priority P1 27 5 P2 12 1 P3 37 2 P4 19 4 P5 10 3 The processes are assumed to have arrived in the order P1, P2, P3, P4, P5 all at time 0. Draw the Gantt charts that **illustrate** the execution of these processes using the following scheduling algorithms: FCFS and Priority. Also **determine** the average waiting time and average turnaround time for each of the algorithms.	5	20
9	**What** is Deadlock? **List** the condition that leads to deadlock. **How** deadlock can be prevented.	5	
10	**What** is Scheduler? **Explain** the queuing diagram representation of process scheduler with neat **sketch.**	5	
11	**Define** Synchronization. Briefly **explain** about the types of Synchronization.	5	
TOTAL MARKS		**40**	**30**

SCHEME OF EVALUATION

S.NO	THEORY	MARKS	TOTAL
1	**Part-A** **What** is thread? **List** out the types of threads.	2	10
2	**Define** context switching	2	
3	**Write** about fork() and wait() system calls.	2	
4	**What** is deadlock prevention?	2	

5	**Discuss** the types of Synchronization	2	
	Part-B		
6	**Discuss** the Functionalities of Operating Systems in detail	5	
7	**What** are the various components of operating system structure and explain with a neat sketch.	5	
8	**Explain** about the bankers algorithm for deadlock avoidance *A* (10 instances), *B* (5instances), and *C* (7 instances) Snapshot at time T_0: Allocation Max Available A B C A B C A B C P_0 0 1 0 7 5 3 3 3 2 P_1 2 0 0 3 2 2 P_2 3 0 2 9 0 2 P_3 2 1 1 2 2 2 P_4 0 0 2 4 3 3	5	
9	**What** are the criteria for evaluating the CPU scheduling algorithm	5	20
10	**Consider** Five processes P1 to P5 arrived at same time. They have estimated running time 10,2,6,8 and 4 seconds respectively. Their priorities are 3,2,5,4 and 1 respectively with 5 being highest priority. **Find** the average turnaround time and average waiting time for Round Robin(q=3) and priority scheduling algorithm	5	
11	**What** is critical section to solve the critical section problem.	5	
TOTAL MARKS		**40**	30

SCHEME OF EVALUATION

S.NO	THEORY	MARKS	TOTAL
	Part-A		
1	**Define** Multi Programming and Time Sharing.	2	
2	**What** is a distributed system? Give an example.	2	10
3	**Define** the Process states.	2	
4	**Explain** about SJF.	2	

5	**Write** about Process Management	2	
6	**Part-B** **Explain** the various system calls are used in OS with examples	5	
7	**Explain** the banker's algorithm for deadlock avoidance. *A* (10 instances), *B* (5instances), and *C* (7 instances) Snapshot at time T_0: Allocation Max Available A B C A B C A B C P_0 0 1 0 7 5 3 3 3 2 P_1 2 0 0 3 2 2 P_2 3 0 2 9 0 2 P_3 2 1 1 2 2 2 P_4 0 0 2 4 3 3	5	
8	**Describe** the Round Robin scheduling algorithm. **Illustrate** with an example.	5	
9	**Explain** the methods for handling deadlocks	5	20
10	**Describe** the following scheduling algorithms. a) Priority b) FCFS	5	
11	**What** is the critical section to solve the critical section problem.	5	
TOTAL MARKS		40	**30**

MID-2

SCHEME OF EVALUATION

S.NO	THEORY	MARKS	TOTAL
1	**PART-A** **Define** Virtual memory.	2	10
2	**What** is File sharing?	2	
3	**Explain** aboutlanguage based protection.	2	
4	**How** does the segmentation differ from paging?	2	

5	**What** is meant by monitors?	2	
6	**PART-B** Forthe following page reference string 7,0,1,2,0,3,0,4,2,3,0,3,2,1,2,0,1,7,0,1. Calculate the page faults **applying** the following Page replacement algorithms for a memory with three frames: a) LRU b) FIFO	5	20
7	**What** is Semaphore? Give the implementation of Bounded Buffer Producer Consumer Problem using Semaphore?	5	
8	**Explain** about domain protection mechanism in brief.	5	
9	**Describe**the different types of File allocation methods.	5	
10	**What** is Mutual exclusion? **Explain** Peterson's solution for mutual exclusion problem?	5	
11	**Distinguish** betweenthe Logical and Physical Address Space.	5	
12	**List** the advantages and disadvantages of Demand Paging.	5	
TOTAL		**40**	**30**

SCHEME OF EVALUATION

S.NO	THEORY	MARKS	TOTAL
1	**Part-A** **How** does the process communicate in inter-process communication?	2	10
2	**Define** demand paging.	2	
3	**Write** about the page replacement algorithm.	2	
4	**List** out theFile types.	2	
5	**What** is meant by pipe? **List** the types of pipes	2	

6	**Part-B** **Discuss** the concept of a named pipe (FIFO) and its usage in IPC.	5	
7	Consider the following page reference string: 7,0,1,2,0,3,0,4,2,3,0,3,0,3,2,1,2,0,1,7,0,1.**How** many page faults would occur for the LRU and Optimal page replacement algorithms, assuming three frames and all frames are initially free?	5	
8	a)**Discuss** in detail about different file access methods.	5	
	b) Briefly **explain** the directory organization.		
9	**What** is the reader-writer's problem? **Explain** its solution with semaphore.	5	20
10	**Explain** about performance of demand paging and pure demand paging?	5	
11	**Describe** the advantages of Contiguous allocation and drawbacks of contiguousallocation of disk space.	5	
TOTAL MARKS		**40**	30

SCHEME OF EVALUATION

S.NO	THEORY	MARKS	TOTAL
1	**Part-A** **What** is a message queue?	2	10
2	Brief**explain** page fault andpage fault ratio?	2	
3	**List** out various file attributes?	2	
4	**Write** about read( ),write( ),truncate( ),seek( ) system calls.	2	
5	**Define** internal and external fragmentation?	2	
6	**Part-B** For the following page reference string 7,0,1,2,0,3,0,4,2,3,0,3,2,1,2,0,1,7,0,1. Calculatethe page faults **applying** the following Page replacement algorithms for a memory withthree frames: a) LRU	5	

	b) FIFO		
7	**What** is Demand paging? **Explain** the working of demand paging and also give the advantages and disadvantages of Demand Paging.	5	20
8	**Explain** the file system structure.	5	
9	**Discuss** about resuming processes within a Monitor.	5	
10	**How** to **solve** Dining Philosopher's problem using Monitors?	5	
11	**Explain** the following: a) Virtual file systems b) Indexed allocation	5	
TOTAL MARKS		**40**	**30**

12.Mapping of COs and Pos with PSOs

COURSE	**Relationship of Course outcomes to Program Outcomes (PO AVG)**													
CO-PO&PSO MATRIX	**PO1**	**PO2**	**PO 3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO1 0**	**PO1 1**	**PO1 2**	**PSO 1**	**PSO 2**
CO1	2	-	-	-	-	-	-	-	-	-	-	1	1	1
CO2	2	2	1	1		-	-	-	-	-	-	1	1	1
CO3	2	2	2	1	1	-	-	-	-	-	-	1	1	
CO4	2	2	2		-	-	-	-	-	-	-		1	1
CO5	1	1	1	-	1		-	-	-	-	-	1	1	
AVERAGE	**1.8**	**1.75**	**1.5**	**1**	**1**							**1**	**1**	**1**

Mapping of POs with PEOs

	Program Outcome(PO):											
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
PEOS	**I**	✓	✓				✓						
	II		✓	✓									
	III					✓							✓
	IV	✓											

13.COs,POs,PSOs JUSTIFICATION

COURSE OUTCOMES

CO1	Students will be able to **define** the operating systems concepts, types of operating systems, system calls, process, and threads concepts.**[BTL1][REMEMBERING]**
CO2	Will be able to and be able to **classify** CPU scheduling algorithms and **interpret** the Deadlock handling methods.**[BTL2,5][UNDERSTANDING,EVALUATING]**
CO3	Memorize the process management and synchronization approaches, and **summarize** the IPC mechanisms. **[BTL2][UNDERSTANDING]**
CO4	**Illustrate** Memory management techniques and virtual memory such as Paging, Segmentation, Demand, Paging, and Page Replacement Algorithms. **[BTL2][UNDERSTANDING]**
CO5	Recite the file system interfaces/structure and **describe** the disk management techniques/system calls.**[BTL1][KNOWLEDGE]**

Justification:

COURSE CO-PO&PSO-MATRIX	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	-	-	-	-	-	-	-	-	-	-	1	1	1

CO1: Students will be able to define the operating systems concepts, types of operating systems, system calls, process, and threads concepts.
Correlated with PO-1 is moderate: Because it contributes the knowledge on fundamentals of operating systems and their types which make students get engineering knowledge and student can remember the same. The correlation of CO1 to PO1 is good.
Correlated with PO-12 is Low: Because ithelps to learn for all technical changes in the computer operating systems**.** The correlation of CO1 to PO12 is minimal.
Correlation with PSO-1 is Low: Operating systems basics helps to adapt profession skills and foundation of software development. The correlation of CO1 to PSO1 is Minimal.
Correlation with PSO-2 is Low: It helps the student to perform research on process,threads.The correlation of CO1 to PSO1 is Minimal.

COURSE CO-PO&PSO-MATRIX	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO2	2	2	1	1		-	-	-	-	-	-	1	1	1

CO2: Will be able to and be able to classify CPU scheduling algorithms and interpret the Deadlock handling methods.
Correlated with PO1 is Moderate: Because it provides CPU scheduling algorithms this knowledge is required for all the computer science engineering students. So, correlation is good.
Correlated with PO2 is moderate: contribution to provide solutions for Complex problems is

little so, the correlation is moderate.
Correlated with PO3 is low: It contributes to provide scope of identifying some solution to complex problems but not a complete. So, the correlation of CO2 is minimal.
Correlated with PO4is low: ability to design and conduct investigations on some case studies and low level applications. So, the correlation of CO2 is minimal.
Correlated with PO12 is low: Schedulingalgorithms and process management concepts will help slightly inprofessional career also. So, the correlation of CO2 is low.
Correlated with PSO1 is low: for analyzing the job scheduling and developing minimal knowledge is required. So, the correlation of CO2 is low.
Correlated with PSO2 is low: for application developments and understanding of cutting edge technologies slightly this concepts are going to be useful. So, the correlation of CO2 is low.

COURSE CO-PO&PSO-MATRIX	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO3	2	2	2	1	1	-	-	-	-	-	-	1	1	

CO3: Memorize the process management and synchronization, semaphores, and summarize the IPC mechanisms.
Correlated with PO1is moderate: contribution of this course outcome is good for providing the knowledge of synchronization and . The correlation is moderate.
Correlated with PO2is moderate: the CO3 contributes knowledge of analyzing the problems on prevention, deadlock avoidance, etc. So, the correlation of CO3 is Good.
Correlated with PO3 is moderate: Students get knowledge on process states and their structure like threads, synchronizations, etc. The correlation is good.
Correlated with PO4 is low: The correlation is moderate for providing knowledge like semaphores, cs,and ipc which helps to analyze and interpret the processes. So, the correlation of CO3 is minimal.
Correlated with PO5 is low: Students get knowledge on different techniques of the processes and synchronization. The correlation is low.
Correlated with PO12 low: These concepts such as methods for semaphores, and classical problems slightly help to learn and understand the technologies. So, the correlation of CO3 is

low.
Correlated with PSO1 low: Synchronization problems are helps to analyze, design, and develop applications minimal knowledge is required. So, the correlation of CO3 is low.

COURSE CO-PO&PSO-MATRIX	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO4	2	2	2		-	-	-	-	-	-	-		1	1

CO 4: IllustrateMemory management techniques and virtual memory such as Paging, Segmentation, Demand, Paging, and Page Replacement Algorithms.
Correlated with PO1 is moderate: Because it contributes the knowledge of memory management techniques and page replacement algorithms. So, the correlation of CO4 to PO1 is good.
Correlated with PO2 is moderate: course outcome provides students to identify different page replacement algorithms and management. So, overall, the correlation of CO4 is good.
Correlated with PO3 is moderate: It contributes knowledge on developing complex problems of memory management techniques such as paging, and replacement algorithms. So, overall, the correlation of CO4 is good.
Correlated with PSO1 is low: Memory Management and Virtual Memory, Swapping, Contiguous Allocation, and Paging, are helping to analyze, design, and develop applications minimal knowledge is required. So, the correlation of CO4 is low.
Correlated with PSO2 is low: Students will be able to do research on paging,segmentation concepts.So, the correlation of CO4 is low.

COURSE CO-PO&PSO-MATRIX	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO5	1	1	1	-	1		-	-	-	-	-	1	1	

CO 5: Recite the file system interfaces/structure and describe the disk management techniques/system calls.
Correlated with PO1 is low: Because it contributes the knowledge of file systems, functions, and Unix basic operations. So, the correlation of CO5 to PO1 is low.
Correlated with PO2 is low: to identify system interfaces and operations of Unix operating system So, overall, the correlation of CO5 is minimal.
Correlated with PO3 islow: Itcontributes knowledge on developing and designing file systems/permissions or structures in the Unix environment. So, overall, the correlation of CO5 is good.
Correlated with PO5 is low: Unix operating practice will help students to utilize other tools like Linux mint, Red hat, Ubuntu, etc. So, overall, the correlation of CO5 is minimal.
Correlated with PO12 is low: File systems organizations/permissions and Unix command line environment knowledge will help to analyze and develop apps. the correlation of CO5 is low.
Correlated with PSO1 is low: Minimal Unix basic utility knowledge is required for all computer science students to design and develop applications. So, the correlation of CO5 is low.

14.Attainment of COs,POs AND PSOs (Excel sheet)

AFTER RESULT

15. Previous Question Papers

Code No.: CS303PC | R20 | H.T.No. | | | 8 | R | | | | | | |

CMR ENGINEERING COLLEGE: : HYDERABAD
UGC AUTONOMOUS
II–B.TECH–I–Semester End Examinations (Regular) - January- 2022
OPERATING SYSTEMS
(Common to CSE, IT, CSC, CSD & CSM)

[Time: 3 Hours] **[Max. Marks: 70]**

Note: This question paper contains two parts A and B.
Part A is compulsory which carries 20 marks. Answer all questions in Part A.
Part B consists of 5 Units. Answer any one full question from each unit. Each question carries 10 marks and may have a, b, c as sub questions.

PART-A **(20 Marks)**

1. a) What is meant by Operating System? [2M]
   b) Define Soft-Time Systems. [2M]
   c) What is meant by Context switch? [2M]
   d) What is meant by Message Queues? [2M]
   e) Define Semaphores. [2M]
   f) State the necessary conditions for deadlocks. [2M]
   g) What is meant by Swapping? [2M]
   h) Define Page Buffering Algorithm. [2M]
   i) Define open System Call. [2M]
   j) Demonstrate write, and *close* system calls. [2M]

PART-B **(50 Marks)**

2. Describe Operating System Services in detail. [10M]

OR

3. Write short on the following: [5M]
   i. Process Management. [5M]
   ii. Main Memory Management.

4. Discuss Inter Process Communication in Detail. [10M]

OR

5. Explain the following in detail. [5M]
   i. First-Come First-Served Scheduling (FCFS). [5M]
   ii. Round-Robin Algorithm (RR).

6. Describe Critical Section Problem in Detail. [10M]

OR

7. Explain Banker's Algorithm with a suitable example. [10M]

8. Explain Contiguous Memory Allocation methods. [10M]

OR

9. Explain the Basic concepts of Demand Paging. [10M]

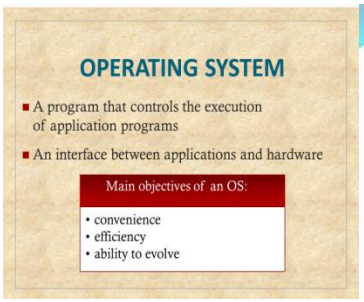
10. Explain Directory structure in file systems. [10M]

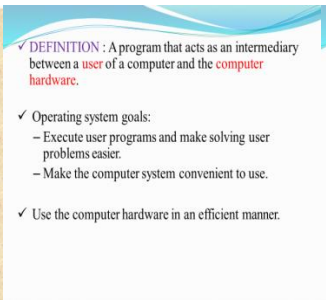
OR

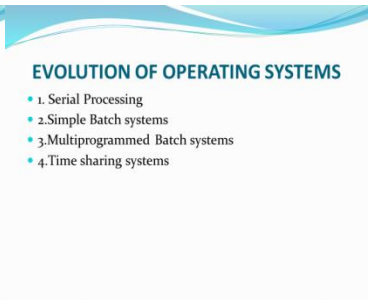
11. Discuss various Protection methods in file system. [10M]

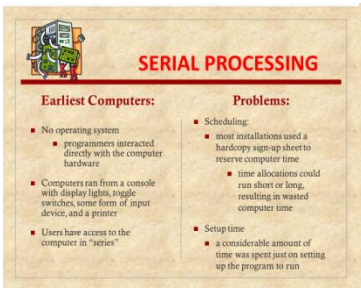
****

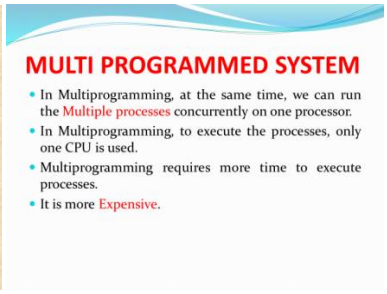
16.Power point presentations (PPTs)

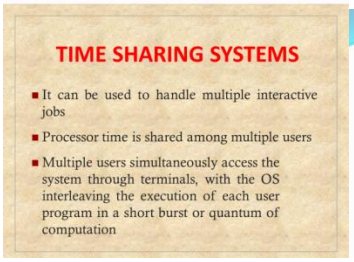


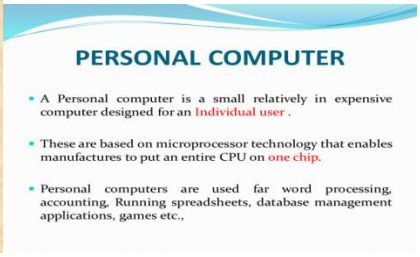


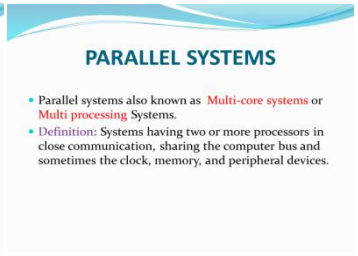


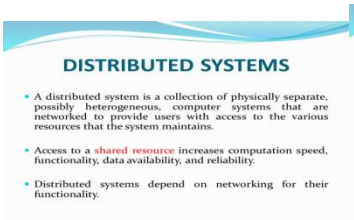


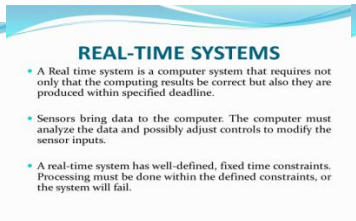


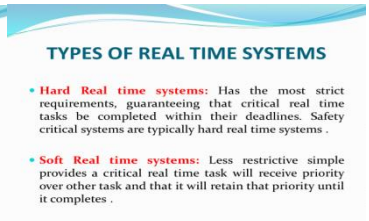


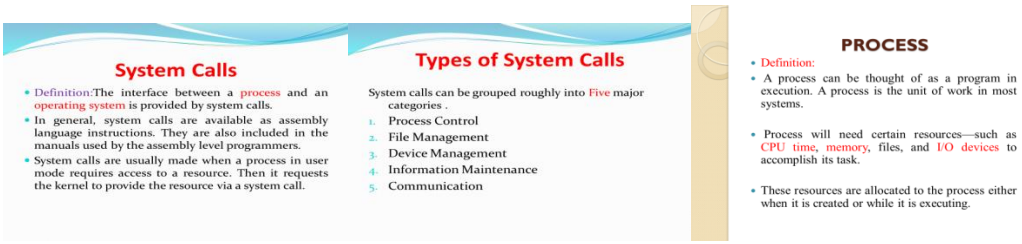


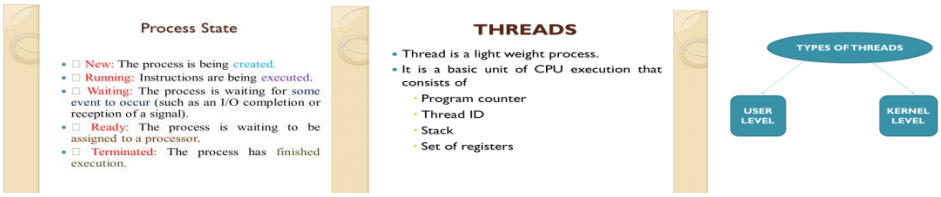












17. Innovative Teaching method if any(Attached Innovative Assignment)

QUESTIONS

1.**Discuss** about Implementation of Access Matrix in detail.**(CO4)**

2. **Explain** and **compare** the SCAN and C-SCAN disk scheduling algorithms. **(CO2)**

18. References (Textbook/Websites/Journals)

Textbooks

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

Websites or URLs e- Resources

https://www.guru99.com/os-tutorial.html

https://www.geeksforgeeks.org/bankers-algorithm-in-operating-system/

https://nptel.ac.in/courses/106/108/106108101/#

https://www.coursera.org/learn/os-power-user

Journals

1. TITLE: **A HAL for component-based embedded operating systems**

AUTHORS:QIMING TENG,HUA WANG,XIANGQUN CHEN
LINK:HTTPS://IEEEXPLORE.IEEE.ORG/DOCUMENT/1508073/AUTHORS

2 TITLE: **Smart Round Robin CPU Scheduling Algorithm For Operating Systems**
AUTHORS: Samkit Mody, Sulalah Mirkar

LINK: https://ieeexplore.ieee.org/document/9114602

3 **TITLE:**Deadlocks in different operating systems

AUTHORS: Helidon Karcanaj,Edra Bumci,Igli Tafa,Julian Fejaz

LINK: https://ieeexplore.ieee.org/abstract/document/7113559

4.TITLE: **The study and improvement of memory management based on SOS**

AUTHORS: FUQING WU, MAX Q-H MENG,LINGFEI WU,ZHUANCHENG ZHANG,XIJUN CHEN

LINK:HTTPS://IEEEXPLORE.IEEE.ORG/DOCUMENT/4913315/AUTHORS#AUTHORS

5. TITLE: **File system design for educational operating system**
AUTHORS:CHANGWEI CHEN,BO QU

LINK:HTTPS://IEEEXPLORE.IEEE.ORG/DOCUMENT/6526223