PRESIDENCY UNIVERSITY

(Established under the Presidency University Act, 2013 of the Karnataka Act 41 of 2013)

[2022-23 EVEN/ WINTER SEMESTER]

COURSE HAND OUT [Revision 02 - Jan 2023]

SCHOOL: School of Engineering **DEPT: CSE** **DATE OF ISSUE: 28-01-2023**

NAME OF THE PROGRAM : Bachelor of Technology

P.R.C. APPROVAL REF. **:** PU/AC18.8/CSE16/CSE2021-25

SEMESTER/YEAR **: 4th semester/2nd Year**

COURSE TITLE & CODE **:** Operating Systems (CSE2010)

COURSE CREDIT STRUCTURE **:** 3-0-3

CONTACT HOURS **:** 3hours/week (45 Hours)

COURSE IC **: Dr. Madhusudhan M V, Ms. Namrata Das**

COURSE INSTRUCTOR(S) **:** Dr. Madhusudhan M V, Ms. Namrata Das, Dr. Md. Sameeruddin Khan, Dr. Saira Banu, Ms. Kokila S, Mr. Shankar J, Dr.L.Shakkeera, Ms. Bhuvaneshwari Patil, Mr. Asif Mohammed H.B., Ms. Sreelatha P K, Mr.Shivalingappa, Mr. Bilal Ahmad Mantoo, Mr. Tanveer Ahmed, Ms. Meena Kumari K S

COURSEURL:https://presiuniv.knimbus.com/user#/searchresultsearchId=eBook&curPage=0&layout=grid&sorFieldId=none&topresult=false&content=*cloud*

PROGRAM OUTCOMES **:**

PO 1: Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO 2: Problem analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

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.

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.

PO 5: 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

PO6: The engineer and society: Apply reasoning in formed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO 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.

PO 8: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9: Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multi-disciplinary settings.

PO 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.

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 multi-disciplinary environments.

PO 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.

COURSE PREREQUISITES:

Students should have basic knowledge on computers, computer software & hardware, and Computer Organization. Prior programming experience in C is recommended.

COURSE DESCRIPTION:

This course introduces the concepts of operating system design and implementation. It covers the classical operating systems internal algorithms such as process scheduling, synchronization, deadlocks and memory management. The course also enhances the problem solving and systems programming ability.

Topics include: Core concepts of operating systems, such as processes and threads, scheduling, synchronization, deadlocks, memory management, file systems.

COURSE OUTCOMES: On successful completion of the course the students shall be able to: (The outcomes are to be developed using the appropriate action verbs from the Bloom's Taxonomy-the list of verbs are attached)

TABLE 1: COURSE OUTCOMES		
CO	**CO**	**Expected BLOOMS**

Number		LEVEL
CO1	Describe the fundamental concepts of operating Systems	Remember
CO2	Demonstrate various CPU scheduling algorithms.	Application
CO3	Apply synchronization tools to a given problem.	Application
CO4	Discuss various memory management techniques.	Understand

MAPPING OF C.O. WITH P.O. [Mark H/M/L Against each of the C.O. depending on the degree of contribution of the C.O.to the P.O.]

[H-HIGH , M- MODERATE, L-LOW]

CO. No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	**M**									**L**		**L**
CO2	**H**	**H**	**L**		**L**	**L**						**L**
CO3	**H**	**M**	**L**		**H**	**L**						**L**
CO4	**H**	**M**	**L**		**L**					**L**		**M**

COURSE CONTENT (SYLLABUS):

Module1:Introduction **[8 Hours] [Remember Level(1)]**

Overview and Introduction to OS, Operating System Operations, Operating System Services, User and OS interface, System Calls and its types, System Programs and types, Operating System Structure, loaders, linkers, Overview of OS design and implementation.

Module 2:Process Management **[9 Hours] [Application Level(3)]**

Process Concept, Operations on Processes, Inter Process Communication, Introduction to threads - Multithreading Models, Threading Issues, Process Scheduling– Basic concepts, Scheduling Criteria, Scheduling Algorithms: FCFS, SJF, RR, Priority, Practice Problems on Scheduling.

Module 3: Process Synchronization and Deadlocks **[12 Hours] [Application Level(3)]**

The Critical-Section Problem- Peterson's Solution, Synchronization hardware, Semaphores, Classic Problems of Synchronization with Semaphore Solution- Dining Philosopher's Problem / Readers and Writers Problems, . Introduction to Deadlocks, Necessary conditions for deadlock, Resource allocation Graph, Methods for handling deadlock: Deadlock Prevention and Implementation, Deadlock Avoidance and Implementation, Deadlock detection & Recovery from Deadlock.

Module 4:Memory Management and File Systems **[13 Hours] [Understand Level(2)]**

Introduction to Memory Management, Basic hardware-Base and Limit Registers, Address Binding, Logical vs Physical Address Space, Memory Management Unit(MMU), Dynamic loading and linking, Swapping, Contiguous and Non-Contiguous Memory Allocation, Segmentation, Paging - Structure of the Page Table – Virtual Memory and Demand Paging – Page Faults and Page Replacement Algorithms, Copy-on-write, Allocation of Frames – Thrashing.

File concept, Access Methods, Directory and Disk structure

DELIVERY PROCEDURE (PEDAGOGY):

Participative Learning: Page replacement algorithms (through Group Discussion).

Problem Based Learning: Scheduling policies, Deadlocks. (Scenario Based)

Technology Enabled Learning: Evolution of Operating Systems (NPTEL Videos by PCP Bhatt/IISc, Bangalore),
Active learning : Role Play on Scheduling policy, Page Replacement algorithms.
Self-learning topics: Dekker's solution for synchronization, Examples of IPC Systems-POSIX, Mach and Windows XP, Case study of threading examples- Windows XP & Linux Threads.

TABLE 3: SPECIAL DELIVERY METHOD/ PEDAGOGY PLANNED WITH TOPICS				
S. No	**Lecture Number**	**Subtopic as per lesson Plan**	**Pedagogy title/ short explanation of adopted pedagogy**	**** At end of semester please update whether activity was done**
1	**L36**	Page replacement algorithms	Group Discussion	
2	**L13**	Scheduling policies, Deadlocks	Scenario Based	
3	**L14**	Scheduling algorithms	Active Learning	

REFERENCE MATERIALS:

Textbook: Silberschatz A, Galvin P B and Gagne G, *"Operating System Concepts*", 10th edition Wiley, 2018.

Reference books:

1. William Stallings, "Operating systems", Prentice Hall, 7th Edition, Pearson,2013.
2. Andrew S Tanenbaum and Albert S Woodhull, "Operating Systems Design and Implementation", 3rd Edition, Pearson,2015

SPECIFIC GUIDELINES TO STUDENTS:

- Be attentive and regular to the class
- Refer class materials and also you can refer online materials, YouTube videos, NPTELetc.
- Students should come prepared with the topics covered in the previous class
- No make-up for Assignment and Quiz
- Recommended to take NPTEL online certification course

COURSE SCHEDULE:

TABLE 4: COURSE BROAD SCHEDULE				
Sl. No.	**ACTIVITY**	**PLANNED STARTING DATE**	**PLANNED CONCLUDING DATE**	**TOTAL NUMBER OF PERIODS**
01	**Over View of the course**	**16/2/23**	**16/2/23**	**1**
02	**Module : 01**	**20/2/23**	**10/3/23**	**8**
02	**Module: 02**	**13/3/23**	**6/4/23**	**9**
03	**Assignment/any other activity/Guest Lecture/ Field Visit**	**8/4/23**	**8/4/23**	**1**
04	**Midterm**	**10/4/23**	**15/4/23**	
05	**Module:03**	**17/4/23**	**12/5/23**	**12**
06	**Module:04**	**15/5/23**	**8/6/23**	**13**
07	**Revision**	**9/6/23**	**9/6/23**	**1**

DETAILED SCHEDULE OF INSTRUCTION:

TABLE 5: DETAILED COURSE SCHEDULE/ LESSON PLAN				
Session no	**TOPIC**	**SUBTOPIC**	**CO Number**	**Reference**
1	Overview and Introduction to Operating System	Basic Operating System and examples of Operating Systems, Definition, Need of Operating System	CO1	T1-Ch01-1.1,1.2
2	Operating System Structure,	OS structures: Monolithic, Layered, Micro-kernel, modular and hybrid	CO1	T1-Ch01-1.4
3	Operations	Functions of OS- Process management, file management, memory management, device management, security, job accounting, control over system performance, error detecting.	CO1	T1-Ch01 1.5
4	OS services, User and OS interface	Program execution, I/O operations, File System manipulation, Communication, Error Detection, Resource Allocation, Protection, User-OS interface : CLI, GUI, Touch-screen, choice of interface	CO1	T1-Ch02-2.1,2.2
5	System Calls, System program	System calls and types- Process control, File management, Device management, information maintenance, communication and protection System program and types- file management, file modification,	CO1	T1-Ch02-2.3,2.4

		status information, programming language support		
6	Linkers and loaders	Linker, loader	CO1	T1-Ch02-2.5
7	OS structure	OS structure	CO1	T1-Ch02-2.7
8	Overview of OS design and implementation	Design policies and implementation	CO1	T1-Ch02-2.6
MODULE 1 Completed				
9	Process Concept	Process Vs Program, Process states and transition, PCB, Context Switching	CO2	T1-Ch03-3.1,3.2
10	Operations on Process	Parent and Child process , Creation and termination of Process, IPC	CO2	T1-Ch03-3.3
11	Inter-process Communication	Direct, Indirect, Buffering & Synchronization	CO2	T1-Ch03-3.4
12	Introduction to threads	Introduction to threads, Single threaded and Multithreaded processes, Benefits	CO2	T1-Ch04-4.1
13	Multithreading models	Many-to-one, one-to-one, one-to-many, Threading issues	CO2	T1-Ch04-4.2,4.4
14	Basic concepts of scheduling	Basics, types of schedulers, Scheduling Criteria	CO2	T1-Ch05-5.1,5.3
15	Scheduling Algorithms:	FCFS and practice problems	CO2	T1-Ch05-5.3
16	Scheduling Algorithms:	SJF/SRTF and practice problems	CO2	T1-Ch05-5.3
17	Scheduling Algorithms:	Round Robin and Priority scheduling , practice problems	CO2	T1-Ch05-5.3
MODULE 2 Completed				
MIDTERM				
18	Introduction to critical section	Definition, solution to Critical section problem	CO3	T1-Ch06-6.1,6.2
19	Peterson Solution	Peterson Solution	CO3	T1-Ch06-6.3
20	Synchronization hardware	Synchronization hardware	CO3	T1-Ch06-6.4
21	Semaphore	Definition, Types, Operations	CO3	T1-Ch06-6.5
22	Classical Examples	Dining Philosopher's problem, Reader-writer problem	CO3	T1-Ch06-6.6
23	Dining Philosopher problem solution	Dining Philosopher problem solution using semaphore	CO3	T1-Ch06-6.8
24	Introduction to Deadlocks	Definition, deadlock Characterization – necessary conditions for deadlock	CO3	T1-Ch07-7.1,7.2

25	Deadlock Characterisation	Resource allocation graph,	CO3	T1-Ch07-7.3
26	Methods of handling deadlock	Deadlock prevention and deadlock avoidance	CO3	T1-Ch07-7.4
27	Deadlock avoidance	Safe state, RAG and Banker's algorithm	CO3	T1-Ch07-7.5
28	Deadlock avoidance	Banker's algorithm	CO3	T1-Ch07-7.6
29	Deadlock detection and Recovery	Deadlock detection and Recovery	CO3	T1-Ch07-7.7
MODULE 3 Completed				
30	Introduction to Memory Management	Introduction, Basic hardware-Base and Limit Registers, Address Binding, Logical vs Physical Address Space	CO4	T1-Ch08-8.1
31	Memory Management Unit(MMU), Dynamic loading and linking	Memory Management Unit(MMU), Dynamic loading and linking	CO4	T1-Ch08-8.1
32	Swapping, Contiguous and Non-Contiguous Memory Allocation	Swapping, Contiguous and Non-Contiguous Memory Allocation	CO4	T1-Ch08-8.2, 8.3
33	Segmentation	Segmentation	CO4	T1-Ch08-8.4
34	Paging - Structure of the Page Table	Paging - Structure of the Page Table	CO4	T1-Ch08-8.4
35	Structure of the Page Table	Structure of the Page Table	CO4	T1-Ch08-8.5
36	Virtual Memory and Demand Paging	Virtual Memory, Virtual Address Space and Demand Paging, Pure Demand Paging, Locality of Reference	CO4	T1-Ch9-9.1
37	Page Faults and Page Replacement Algorithms	Basic and FIFO page replacement algorithms (concept with practice problems)	CO4	T1-Ch9-9.4
38	Page Replacement Algorithms	Optimal and LRU page replacement algorithms(concept with practice problems), Copy on write	CO4	T1-Ch9-9.4
39	Allocation of Frames	Allocation of Frames	CO4	T1-Ch9-9.5
40	Thrashing	Cause and Working-Set Model	CO4	T1-Ch9-9.6
41	File Concepts, Access Methods	File Concepts, Access Methods	CO4	T1-Ch10-10.1,10.2
42	Directory and disk structure	Directory and disk structure	CO4	T1-Ch10-10.3
MODULE 4 Completed				
Revision				
END TERM				

ASSESSMENT SCHEDULE:

TABLE 6 ASSESSMENT SCHEDULE							
Sl. no	**Assessment type**	**Contents**	**Course outcome Number**	**Duration In Hours**	**marks**	**Weightage**	**Venue, DATE &TIME**
1	**Assignment 1** https://presiuniv.knimbus.com/user#/searchresultsearchId=eBook&curPage=0&layout=grid&sorFieldId=none&topresult=false&content=*cloud*	**OS Services OS Structures Scheduling algorithms IPC**	**CO1, CO2**	**1 hour**	**10**	**5%**	**To be notified later**
	Surprise Test-1	**Module-1**	**CO1**	**30 min**	**10**	**5%**	**To be notified later**
	Surprise Test-2	**Module-2**	**CO2**	**30 min**	**10**	**5%**	**To be notified later**
2	**Midterm**	**Modules 1 and 2**	**CO1, CO2**	**2 hours**	**50**	**25%**	**As received from COE**
3	**Surprise test 3**	**Module 3**	**CO3**	**30 min**	**10**	**5%**	**To be notified later**
4	**Assignment2** https://presiuniv.knimbus.com/user#/searchresultsearchId=eBook&curPage=0&layout=grid&sorFieldId=none&topresult=false&content=*cloud*	**Classic Problems of Synchronization Problems on deadlocks Virtual Memory and Demand Paging**	**CO3, CO4**	**1 hour**	**10**	**5%**	**To be notified later**
5	**Endterm**	**Modules 1, 2, 3, 4**	**CO1, CO2, CO3, CO4**	**3 hours**	**100**	**50%**	**As received from COE**

COURSE CLEARANCE CRITERIA:

("AS PER ACADEMIC REGULATIONS OF THE UNIVERSITY")

MAKEUP EXAM POLICY:b

("AS PER ACADEMIC REGULATIONS OF THE UNIVERSITY")

CONTACT TIMINGS IN THE CHAMBER FOR ANY DISCUSSIONS:

To be notified by the Instructor based on the timetable.

SAMPLE THOUGHT PROVOKING QUESTIONS:

TABLE 7: SAMPLE THOUGHT PROVOKING QUESTIONS

SL NO	QUESTION	MARKS	COURSE OUTCOME NO.	BLOOM'S LEVEL
1.	Can you run your executable code [.exe file] on a system which is not having an OS? Elaborate youranswer.	2	CO1	Remember
2.	During a process switch [context switching],theoperatingsystemexecutes instructions that choose the next process to execute. These instructions are typically at a fixed location inmemory. Why?	2	CO2	Understand
3.	Imagine a Railway Ticketing Counter. ● Initially there are 3 counters. ● There is a security guard who keeps a check on the people so that no one breaks the line. ● Each counter has2 people waiting inline. ● The people waiting in line came in as per the alphabetical order. A new 4th counter is being opened. And therearetwo new persons G and H about to join the linesecurity guard, now you who can be processedget to the counter at the new aremarked1,2,3and4). People waiting inline (A, B, C and so on. Here t, followed by B and then C etc. Answer	10	CO2	Application
4.	Consider the following page reference string: 1, 2, 3, 4, 2, 1, 5, 6, 2, 1, 2, 3, 7, 6, 3, 2, 1, 2, 3, 6. How many page faults would occurfor	8	CO4	Application

<table>
<tr>
<td></td>
<td>thefollowing replacement algorithms, assuming one, two, three, four, five, six, or seven frames?
Note: Remember all frames are initially empty, so your first unique pages will all cost one faulteach.
• LRUreplacement
• FIFO replacement
• Optimalreplacement</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>A restaurant would like to serve four dinner parties, P1 through P4. The restaurant has a total of 8 plates and 12 bowls. Assume that each group of diners will stop eating and wait for the waiter to bring a requested item (plate or bowl) to the table when it is required. Assumethat the diners don't mind waiting. The maximum request and current allocation tables are shown asfollows:

<table>
<tr><th>Max</th><th>Plates</th><th>Bowls</th><th>Current</th><th>Plates</th><th>Bowls</th></tr>
<tr><td>p1</td><td>7</td><td>7</td><td>p1</td><td>2</td><td>3</td></tr>
<tr><td>p2</td><td>6</td><td>10</td><td>p2</td><td>3</td><td>5</td></tr>
<tr><td>p3</td><td>1</td><td>2</td><td>p3</td><td>0</td><td>1</td></tr>
<tr><td>p4</td><td>2</td><td>4</td><td>p4</td><td>1</td><td>2</td></tr>
</table>

a) Determine the Need Matrix for plates andbowls.
b) Will the restaurant be able to feed all four partiessuccessfully?
Clearly explain your answer – specifically, why not or why/how there is a safe serving order.</td>
<td>8</td>
<td>CO3</td>
<td>Application</td>
</tr>
</table>

TARGET SET FOR COURSE OUTCOME ATTAINMENT:

TABLE 8: TARGET SET FOR ATTAINMENT OF EACH CO and ATTAINMENT ANALYSIS AFTER RESULTS						
Sl.no	**C.O. No.**	**Course Outcomes**	**Threshold Set for the CO**	**Target set for attainment in percentage**	Actual C.O. Attainment In Percentage *	Remarks on attainment &Measures to enhance the attainment *
01	CO1	Describe the fundamental concepts of operatingSystems	55	70		
02	CO2	Demonstrate various CPUschedulingalgorithms.	50	65		
03	CO3	Apply synchronization tools to agivenproblem.	45	60		
04	CO4	Discuss various memorymanagementtechniques.	45	60		

*** LAST TWO COLUMNS ARE TO BE FILLED AFTER END TERM EXAM WITH ACTUAL ATTAINMENT VALUES**

Signature of the course Instructor In-Charge (s)

APPROVAL:

This course has been duly verified Approved by the D.A.C.

Signature of the Chairperson D.A.C.

Name and signature of the Instructor In-Charge (s) AFTER completing entries in Table number 3 and 8 at end of semester:

Name and signature of the DAC Chairperson AFTER completing entries in Table number 3 and 8 at end of semester:

BLOOM'S TAXONOMY SAMPLE VERBS

Learning Outcomes Verbs at Each Bloom Taxonomy Level to be used for writing the course Outcomes.

REMEMBER	UNDERSTAND	APPLY	ANALYZE	EVALUATE	CREATE
Arrange Define	**Classify Compare**	**Apply Change**	**Analyze Appraise**	**Appraise Argue**	**Arrange Assemble**

Describe	**Compute**	**Choose**	**Break down**	**Assess**	**Construct**
Duplicate	**Convert**	**Calculate**	**Calculate**	**Choose**	**Collect**
Identify	**Contrast**	**Classify**	**Categorize**	**Compare**	**Compose**
Label	**Defend**	**Demonstrate**	**Compare**	**Contrast**	**Create**
List	**Describe**	**Determine**	**Contrast**	**Criticize**	**Design**
Match	**Differentiate**	**Employ**	**Criticize**	**Defend**	**Develop**
Name	**Distinguish**	**Examine**	**Debate**	**Discriminate**	**Formulate**
Order	**Estimate**	**Illustrate**	**Diagram**	**Estimate**	**Integrate**
Outline	**Explain**	**Interpret**	**Differentiate**	**Evaluate**	**Manage**
Recite	**Extrapolate**	**Modify**	**Discriminate**	**Explain**	**Organize**
Recognize	**Generalize**	**Operate**	**Distinguish**	**Interpret**	**Plan**
Relate	**Interpolate**	**Practice**	**Examine**	**Judge**	**Prepare**
Repeat	**Locate**	**Predict**	**Experiment**	**Measure**	**Prescribe**
Reproduce	**Paraphrase**	**Prepare**	**Indentify**	**Predict**	**Produce**
Select	**Predict**	**Produce**	**Infer**	**Rank**	**Propose**
State	**Recognize**	**Restructure**	**Inventory**	**Rate**	**Specify**
Tabulate	**Review**	**Schedule**	**Relate**	**Recommend**	**Synthesize**
Tell	**Summarize**	**Sketch**	**Separate**	**Select**	**Write**
	Translate	**Solve**	**Subdivide**	**Support**	
		Use	**Test**	**Validate**	