PRESIDENCY UNIVERSITY

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

ACA-2[2019] COURSE HAND OUT

SCHOOL: School of Engineering **DEPT.:** CSE **DATE OF ISSUE: 10th August 2020**

NAME OF THE PROGRAM: B.Tech

P.R.C. APPROVAL REF.: **PU/AC-11/6/06_2019**

SEMESTER/YEAR: 5th Semester/2020-2021

COURSE TITLE & CODE: Operating Systems CSE 210

COURSE CREDIT STRUCTURE: 3-0-0-3

CONTACT HOURS: 3hrs/week (41 Hrs)

COURSE INSTRUCTOR(S): Asif Mohamed H B (IC), Sunilkumar Teggihalli, Ila Chandrakar, Lakshmisha, Nikita, Sneha S Bagalkot, Tapas Guha, Rupam Bhagawati

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. (H)**

PO 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. (M)

PO 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. (L)**

PO 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.

PO 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.

PO 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.

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.

PO 9: Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary 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. (L)

PO 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.

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. (L)

COURSE PREREQUISITES:

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

COURSE DESCRIPTION: Operating systems being central to computing activities, this Course provide understanding of the functions and functional modules of operating systems. The design and implementation of Operating systems is also covered.

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

COURSE OBJECTIVES

To learn the basic concepts and functions of operating systems (OS).
To learn the mechanisms of OS to handle processes and threads and their communication.
To study the basic components of scheduling mechanism.
To learn memory management strategies in contemporary OS.
To appreciate the emerging trends in operating systems.

COURSE OUTCOMES: On successful completion of the course the students shall be able to:

CO1. Describe the fundamental concepts of operating Systems. (Knowledge Level)

CO2. Demonstrate various CPU scheduling algorithms. (Application Level)

CO3. Explain the process synchronization and deadlocks in operating systems. (Comprehension Level)

CO4. Discuss various memory management techniques. (Comprehension Level)

MAPPING OF C.O. WITH P.O. [H-HIGH, M- MODERATE, L-LOW]

C.O.N0.	P.O.01	P.O.02	P.O.03	P.O.10	P.O.12
C.O. 01	M			L	L
C.O. 02	H	H	L		L
C.O. 03	H	M	L		L
C.O. 04	H	M	L	L	M

COURSE CONTENT (SYLLABUS):

Module 1: Introduction [10 Hrs] [Knowledge Level (1)]

Introduction to OS – Operating System Architecture & Operations – Operating System functions and components - Operating System computing environment – system software, loaders, linkers, assemblers, windowing systems, System Calls.

Module 2: Process Scheduling **[9 Hrs] [Application Level (3)]**

Introduction to threads - Multithreading Models - Basic Concepts of CPU Scheduling– Scheduling Algorithms: FCFS, SJF, RR, Priority, Multilevel Queue, Multilevel Feedback Queue.

Module 3: Process Synchronization and Deadlocks [10 Hrs] [Comprehension Level (2)]

The Critical-Section Problem- Peterson's Solution- Semaphores, Classic Problems of Synchronization, Monitors. Introduction to Deadlocks, Necessary conditions for deadlock, deadlock Characterization, Deadlock Prevention- Deadlock Avoidance- Deadlock detection & recovery from Deadlock.

Module 4: Memory and Storage Management [12 Hrs] [Comprehension Level (2)]

Contiguous and Non-Contiguous Memory Allocation – Paging - Structure of the Page Table - Swapping – Demand Paging – Page Replacement – Segmentation – Allocation of Frames – Thrashing. Disk Structure - Disk Management - DISK Scheduling: FCFS, SSTF, SCAN, C-SCAN, LOOK. File System: Concept, Structure, Access Methods and allocation and protection methods.

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), Disk Structure (Edhitch), File allocation techniques (NPTEL Videos by PCP Bhatt,IISc, Bangalore).

Active learning:

1. Role Play on Scheduling policy
2. Real time illustration on File Types, access and Allocation

Self-learning topics: OS design and Implementation, Threading Issues, Syn. Of Hardware and Dekkers solution, Directory structure. Remaining topics will be delivered through lecture.

REFERENCE MATERIALS: Textbooks, reference books, any other resources, like webpages.

Textbook: Silberschatz A, Galvin P B and Gagne G, *"Operating System Concepts*", 9th edition Wiley, 2009.

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

GUIDELINES TO STUDENTS:

- Be attentive and regular to class
- Refer class materials and also you can refer online materials, YouTube videos, NPTEL etc.
- Students should come prepared with the basics of the topics that will be covered in the next class
- No make-up for Assignment and Quiz
- Recommended to take NPTEL online certification course
- All course related information will be displayed on the SoE notice board

COURSE SCHEDULE:

Sl. No.	ACTIVITY	STARTING DATE	CONCLUDING DATE	TOTAL NUMBER OF PERIODS
01	Over View of the course	10/8/2020	11/8/2020	2
02	Module : 01	12/8/2020	4/9/2020	9
03	Assessment 1	4/9/2020		1
04	Module: 02	7/9/2020	23/9/2020	8
05	Assessment 2	24/9/2020		1
06	Test-1	25/9/2020	28/9/2020	1
07	Module:03	5/10/2020	28/10/2020	9
08	Assessment 3	30/10/2020		1
09	Module:04	2/11/2020	8/12/2020	11
10	Assessment 4	9/12/2020		1

11	**Test-2**	**11/11/2020**	**13/11/2020**	**1**
12	Revison	10/12/2020		**1**
13	**End Term**	**15/12/2020**	**13/1/2021**	

SCHEDULE OF INSTRUCTION:

Sl. no	Session no[date if possible]	Lesson Title	Topics	Course Outcome Number	Delivery Mode	Reference
1	**S1**	Introduction to OS	Definition, Need of Operating System, OS timeline	**CO.No.1**	**PPT, CHALK AND TALK**	T1,ch1
2	S2	Operating System Architecture & Operations	Computer System Architecture- Single & Multi processor, Clustered System, Dual Mode Operations, Cpu & Hardware Protection	**CO.No.1**	**PPT**	T1,ch1
3	**S3**	Operating System Services and components	Operating System Services – Program execution, I/O, File interface, communication & Error detection OS System components – Process, memory, I/O, Disk, File management	**CO.No.1**	**PPT**	T1,ch2
4	**S4**	Operating System computing environment	Traditional, Mobile, P2P, Distributed, Client-Server, Virtualization, Cloud & Real Time environment	**CO.No.1**	**PPT**	T1,ch2
5	S5	System software	Definition, loaders, linkers, assemblers system calss-Three general methods, Types of System Calls	**CO.No.1**	**PPT, CHALK AND TALK**	T1,ch2

6	S6	Operating System Structures	Simple, Layered, Micorkernel, Modular, iOS, Android OS	**CO.No.1**	**PPT**	T1,ch2
7	S7	Process Concept	Process Vs Program, Process states and transition, PCB, Context Switching, Operations on Processes	**CO.No.1**	**PPT**	T1,ch3
8	S8	Interprocess Communication	Direct, Indirect, Buffering & Synchronization	**CO.No.1**	**PPT, CHALK AND TALK**	T1,ch3
9	S9	Revision/Buffer class				
10	S10	Assessment 1 – Class Test				
Module 1 completed						
11	S11	Introduction to Threads	Introduction to threads, Single threaded and Multi-threaded processes, Benefits	**CO.No.2**	**PPT**	T1,ch4
12	**S12**	Multithreading Models	Types of multithreading models	**CO.No.2**	**PPT**	T1,ch4
13	S13	Basic Concepts of CPU Scheduling	Basics, types of schedulers, Scheduling Criteria	**CO.No.2**	**PPT**	T1,ch6
14	S14	Scheduling Algorithms:	FCFS and problems on FCFS	**CO.No.2**	**Problem Based Learning, CHALK & TALK**	T1,ch6
15	S15	Scheduling Algorithms:	SJF and problems on SJF, SRTF	**CO.No.2**	**Problem Based Learning, CHALK & TALK**	T1,ch6
16	S16	Scheduling Algorithms:	PS and problems on PS	**CO.No.2**	**Problem Based Learning, CHALK & TALK**	T1,ch6
17	S17	Scheduling Algorithms:	RR and problems on RR	**CO.No.2**	**Problem Based Learning, CHALK & TALK**	T1,ch6
18	S18	Scheduling Algorithms:	Multi-level Queue with and without feed-back.	**CO.No.2**	**PPT, CHALK AND TALK**	T1,ch6

19	**S19**	Assessment 2 – Problem solving (Class Based)				
Module 2 completed						
20	**S20**	Introduction to critical section	Definition, Conditions in CS problem	**CO.No.3**	**PPT, CHALK AND TALK**	T1,ch5
21	**S21**	Peterson Solution	Algorithm 1, Algorithm 2 and Peterson solution for 2 process	**CO.No.3**	**PPT, CHALK AND TALK**	T1,ch5
22	S22	Semaphore	Definition, Types, Operations, Busy waiting	**CO.No.3**	**PPT, CHALK AND TALK**	T1, ch5
23	S23	Classical Examples	Bounded buffer problem and Reader writer Problem	**CO.No.3**	**PPT, CHALK AND TALK**	T1,ch5
24	S24	Monitor	Definition, Dining Philosopher problem solution using Monitor	**CO.No.3**	**PPT, CHALK AND TALK**	T1,ch5
25	**S25**	Introduction to Deadlocks	Definition, Necessary conditions for deadlock, deadlock Characterization	**CO.No.3**	**PPT, CHALK AND TALK**	T1, ch7
26	S26	Deadlock Prevention	Prevention techniques	**CO.No.3**	**PPT, CHALK AND TALK**	T1, ch7
27	S27	Deadlock Avoidance	RAG, Bankers algorithm	**CO.No.3**	**Problem Based Learning, CHALK & TALK**	T1, ch7
28	**S28**	Deadlock detection and Recovery	Detection algorithm and Recovery schemes	**CO.No.3**	**PPT, CHALK AND TALK**	T1, ch7
29	S29	Assessment 3 – Quiz				
Module 3 completed						
30	S30	Contiguous and Non-Contiguous Memory Allocation	Simple allocation, Variable allocation, Compaction, Dynamic Storage Allocation	**CO.No.4**	**Problem Based Learning, CHALK & TALK**	T1, ch8
31	**S31**	Paging	Definition, Need, Paging hardware and implementation	**CO.No.4**	**PPT**	T1, ch8

32	S32	Structure of the Page Table -	Definition, types of page table and structures	**CO.No.4**	**PPT**	T1, ch8
33	S33	Swapping – Demand Paging	Need for swapping, Why demand paging	**CO.No.4**	**PPT**	T1, ch9
34	S34	Page Replacement	Need for page replacement, Algorithms – FIFO, OPTIMAL, LRU, MFU, LFU	**CO.No.4**	**Participative Learning**	T1, ch9
35	S35	Segmentation	Need for Segmentation, Combine paging with segmentation	**CO.No.4**	**PPT**	T1, ch8
36	S36	Allocation of Frames – Thrashing	Allocation of Frames – Thrashing	**CO.No.4**	**PPT**	T1, ch9
37	S37	Disk Structure - Disk Management	Disk structure, booting, Bad block	**CO.No.4**	**Technology Enabled Learning**	T1,ch10
38	S38	DISK Scheduling	FCSFS, SSTF, SCAN, C-SCAN, LOOK, C-LOOK	**CO.No.4**	**Problem Based Learning, CHALK & TALK**	T1,ch10
39	S39	File System	File Concept, Structure, access Methods, Protection	**CO.No.4**	**Problem Based Learning, CHALK & TALK**	T1,ch11
40	S40	File System	File allocation methods – Contiguous, Linked and Indexed Allocation	**CO.No.4**	**Problem Based Learning, CHALK & TALK**	T1,ch12
		Assignment 4 - Written assignment and upload in Edhitch				
41	S41	Revision				
Module 4 completed						

ASSESSMENT SCHEDULE:

Sl.no	Assessment type	contents	Course outcome Number	Duration In Hours	marks	weightage	Venue, DATE &TIME
1	Assessment 1 – Class Test	**Based on module 1**	**CO 1**	**1 hr**	**10**	**5%**	**CLASSROOM, S10**

2	Assessment 2 – Problem solving Assignment 1	**Based on module 2**	**CO 2**	**1 hr**	**10**	**5%**	**CLASSROOM, S19**
3	Assessment 3 – Quiz	**Based on module 3**	**CO 3**	**1 hr**	**10**	**5%**	**CLASSROOM, S29**
4	Assessment 4 - Written assignment 2 and upload in Edhitch	**Based on module 4**	**CO 4**	**1 hr**	**10**	**5%**	**HOMEWORK**
5	**Test 1**	**Based on module 1 and 2**	**CO 1 and CO 2**	**1 hr**	**40**	**20%**	**25/8/2020 to 28/8/2020**
6	**Test 2**	**Based on module 2 and 3**	**CO 2 and CO 3**	**1 hr**	**40**	**20%**	**11/11/2020 to 13/11/2020**
7	**End Term**	**Based on module 1, 2, 3 &4**	**CO 1, CO 2, CO 3 & CO4**	**3 hr**	**80**	**40%**	**15/12/2020 to 13/1/2021**

COURSE CLEARANCE CRITERIA: (Here mention the minimum requirements of attendance, marks in continuous assessment & term end examination, make-up exam policy and other details as per the academic regulations & PRC):

Students are advised to maintain a minimum attendance of 75% in this course. Failing which, the student will not be permitted to attend the end term examination and subsequently awarded "NP" grade.

Also, minimum performance of 40% (48 marks/120) in continuous assessment and 30% (24 marks/80) in end term exam is required to clear the course. Failing which, the student will be awarded "NE" (not eligible) grade and/or "F" (fail) grade respectively.

CONTACT TIMINGS IN THE CHAMBER FOR ANY DISCUSSIONS:

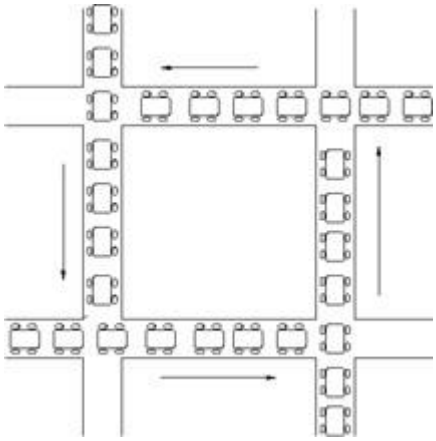
To be notified by the Instructor based on the timetable.

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 your answer.	2	CO.No.1	Knowledge

2.	During a process switch [context switching], the operating system executes instructions that choose the next process to execute. These instructions are typically at a fixed location in memory. Why?	2	CO.No.1	Comprehension
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 has 2 people waiting in line. The people waiting in line came in as per the alphabetical order. ● A new 4th counter is being opened. And there are two new persons G and H about to join the line. You are the security guard, now you get to choose who can be processed at the new counter. Counters are marked 1, 2, 3 and 4 (blue boxes). People waiting in line are marked A, B, C and so on. Here A came first, followed by B and then C etc. Answer logic behind this.	10	CO.No2	Application
4.	Using semaphores write a solution [code/pseudo code] to the below readers-writers problem. That is once the writer is ready the writer performs its write as soon as possible. [In other words when a reader arrives and a writer is waiting, the reader is suspended behind the writer. This means writers are given higher priority over readers].	8	CO.No.3	Comprehension

<table>
<tr>
<td>5.</td>
<td>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 occur for the following 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 fault each.
•LRU replacement
•FIFO replacement
•Optimal replacement</td>
<td>8</td>
<td>CO.No.4</td>
<td>Knowledge</td>
</tr>
<tr>
<td>6</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. Assume that the diners don't mind waiting. The maximum request and current allocation tables are shown as follows:
<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>
</td>
<td>8</td>
<td>CO.No.3</td>
<td>Comprehension</td>
</tr>
</table>

	a) Determine the Need Matrix for plates and bowls. b) b. Will the restaurant be able to feed all four parties successfully? Clearly explain your answer – specifically, why not or why/how there is a safe serving order.			
7	Consider the traffic deadlock diagram  a. Show that the four necessary conditions for deadlock indeed hold in this example. b. State a simple rule that will avoid deadlocks in this system.	8	CO.No.3	Comprehension

Target set for course Outcome attainment:

Sl.no	C.O. No.	Course Outcomes	Target set for attainment in percentage
01	CO1	Describe the fundamental concepts of operating Systems.	75
02	CO2	Demonstrate various CPU scheduling algorithms.	70
03	CO3	Explain the process synchronization and deadlocks in operating systems.	65
04	CO4	Discuss various memory management techniques.	65

Signature of the course Instructor

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

Signature of the Chairperson D.A.C.

Course Completion Remarks &Self-Assessment.[This has to be filled after the completion of the course]

[Please mention about the course coverage details w.r.t. the schedule prepared and implemented. Any specific suggestions to incorporate in the course content. Any Innovative practices followed and its experience. Any specific suggestions from the students about the content, Delivery, Evaluation etc.]

Sl.no.	Activity As listed in the course Schedule	Scheduled Completion Date	Actual Completion Date	Remarks

Any specific suggestion/Observations on content/coverage/pedagogical methods used etc.:

Course Outcome Attainment:

Sl.no	C.O. No.	Course Outcomes	Target set for attainment in percentage	Actual C.O. Attainment In Percentage	Remarks on attainment &Measures to enhance the attainment
01	Co1				
02	Co2				
03					
04					
05					
06					

Name and signature of the Faculty member:

D.A.C. observation and approval:

BLOOM'S TAXONOMY

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

Cognitive Level	Illustrative Verbs	Definitions
Knowledge	arrange, define, describe, duplicate, identify, label, list, match, memorize, name, order, outline, recognize, relate, recall, repeat, reproduce, select, state	remembering previously learned information
Comprehension	classify, convert, defend, discuss, distinguish, estimate, explain, express, extend, generalize, give example(s), identify, indicate, infer, locate, paraphrase, predict, recognize, rewrite, report, restate, review, select, summarize, translate	grasping the meaning of information
Application	apply, change, choose, compute, demonstrate, discover, dramatize, employ, illustrate, interpret, manipulate, modify, operate, practice, predict, prepare, produce, relate schedule, show, sketch, solve, use write	applying knowledge to actual situations
Analysis	analyze, appraise, breakdown, calculate, categorize, classify, compare, contrast, criticize, derive, diagram, differentiate, discriminate, distinguish, examine, experiment,	breaking down objects or ideas into simpler parts and seeing how the parts relate and are organized

	identify, illustrate, infer, interpret, model, outline, point out, question, relate, select, separate, subdivide, test	
Synthesis	arrange, assemble, categorize, collect, combine, comply, compose, construct, create, design, develop, devise, explain, formulate, generate, plan, prepare, propose, rearrange, reconstruct, relate, reorganize, revise, rewrite, set up, summarize, synthesize, tell, write	rearranging component ideas into a new whole
Evaluation	appraise, argue, assess, attach, choose, compare, conclude, contrast, defend, describe, discriminate, estimate, evaluate, explain, judge, justify, interpret, relate, predict, rate, select, summarize, support, value	making judgments based on internal evidence or external criteria