

UNITED TECHNICAL COLLEGE
Semester-Fall

Level: Bachelor
 Programme: BE
 Course: Operating System

Year : 2024
 Full Marks: 100
 Pass Marks: 45
 Time : 3hrs.

Candidates are required to give their answers in their own words as far as practicable.

The figures in the margin indicate full marks.

Attempt all the questions.

1. a) Define Operating System. Explain different services provided by operating system. 8
- b) Draw and describe process state diagram. What types of operations are performed in a process? 7
2. a) Do you feel deadlock is great enemy of computer system? If yes, why? Also write protection mechanism for deadlock. 8
- b) When multiple processes need to cooperate, there is a choice between shared memory and inter-process communication (IPC). Compare and contrast these two techniques. What is the role of the operating system in each? 7
3. a) Explain how the producer-consumer problem is relevant to an operating system. Describe briefly the semaphore-based solution to this problem. 7
- b) Consider following set of processes along with their burst time, arrival time and priorities. Calculate average waiting time and average turnaround time using following scheduling. 8
 - i. FCFS
 - ii. SJF
 - iii. Priority (Preemptive)
 - iv. HRRN

Process	Arrival Time	Burst Time	Priority
A	0	3	5
B	2	6	4

C	4	4	1
D	6	5	3
E	8	2	2

4. a) How many page faults occur for following reference strings for three page frames? 8
 7,0,1,2,0,3,0,4,2,3,0,3,2,1,2,1,2,0,3
 Using LRU, FIFO and Optimal page replacement algorithm.
- b) Differentiate virtual page and a page frame. What is the difference between LRU and NRU page replacement algorithms? 7
5. a) Disk request come to the disk driver for cylinder 6, 8, 18, 16, 25, 38 and 36 in that order. A seek take 5msec per cylinder move. How much seek time is needed for 8
 i. FCFS
 ii. Closest Cylinder Next
 iii. C-Scan (Initially moving upward)
 iv. Scan (Initially moving downward)
 In all cases, the arm initially at cylinder 18. Also describe which one is best algorithm and why?
- b) Give a scenario where choosing a large file-system block size might be a benefit. Give an example where it might be a hindrance. 7
6. a) Describe OSI layered architecture. How it is important in network architecture of operating system? 7
 b) Describe the process management scheme in either Linux or Microsoft-Windows OS. 8
7. Write short notes on: (Any two) 2×5
 a) Peterson's Algorithm
 b) Context Switching
 c) Fragmentation.

Lambnit Engineering College

Level: Bachelor

Semester - Fall

Year : 2079

Programme: BE

Full Marks : 100

Course: Operating System

Pass Marks : 45

Time : 3 hrs

Candidates are required to give their answer in their own words as far as practicable.

The figure in the margin indicates full marks.

Attempt all the questions.

1. a) Define operating system. "Operating system as a virtual machine and as an extended machine". Clarify this statement with the help of suitable example. [2+6]

b) Explain about real-time operating system with its types. 7

2. a) Differentiate between process and threads. Explain process state transition diagram.

3+5

b) What are the Process states? Briefly explain about Process control block. 7

3. a) Explain in brief about multithreading with the help of suitable example. List out merits and demerits of threads over process. 7

b) Consider a system with five processes P0 through P4 and three resources types A, B, C. Resource type A has 10 instances, B has 5 instances and type C has 7 instances.

Suppose at time t0 following snapshot of the system has been taken: [8]

i. What will be the content of need matrix?

ii. Is the system in safe state? If yes, then what is the safe sequence?

Process	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			

4. a) Explain in brief about context switching? Explain first level interrupt handling (FLII). 7

b) A set of processes with their respective arrival times at the ready queue and the length of their next CPU burst are given below:

Process ID	Arrival Time (in ms)	CPU Burst (in ms)
A	0	6

B	3	3
C	4	6
D	6	4
E	10	2

Determine average-waiting time and average turn-around time using: FCFS, SJF, RR
 (time slice 3 ms), STRF. [8]

OR

Define scheduling. What are criteria for scheduling? Explain real-time scheduling algorithm. [8]

5. a) Consider a swapping system in which memory consists of the following hole sizes in memory order: 10K, 4K, 20K; 18K, 7K, 9K, 12K and 15K. Which hole is for successive segment request of
- 12K
 - 10K
 - 9K
- for first fit? Now repeat the question for best fit, worst fit and next fit. [8]
- b) Disk requests come into the disk driver for cylinders 11, 21, 31, 1, 41, 51, 2, in that order. The head position is at 35. A seek takes 3 msec per cylinder moved. How much seek time is needed for
1. First come First serve FCFS
 2. Shortest Seek First SSF disk scheduling algorithm.
 3. The elevator algorithm for scheduling disk requests.
 4. CSCAN (moving inward) [7]
6. a) List out pros and cons of distributed system over centralized system. Explain Flynn's taxonomy of computer system. [4+4]
- b) Compare and contrast between virus and worm. Explain Access Control List (ACL) and Access Control Matrix (ACM). [3+4]
7. Write short notes on (Any two) 2*5
- a) IPC
 - b) Security in Windows 2000
 - c) Remote procedure calls (RPC)

National Academy of Science and Technology

(Affiliated to Pokhara University)

Dhangadhi, Kailali

Pre-University Examination

Level: Bachelor

Semester: III_Fall

Year : 2023

Program: B.E. Computer

F.M : 100

Course: Operating System

P.M : 45

Time : 3hrs.

Candidates are required to give their answers in their own words as far as practicable. The figures in the margin indicate full marks

Attempt all the questions.

1. a) Define Operating System. Explain with different types with 8 example.

b) Do you think a process can exist without any state? Justify your view with the help of process state transition diagram and PCB. 7

2. a) What is memory management? Explain memory hierarchy. 5

b) Consider following set of processes along with their burst time, arrival time and priorities. Calculate average waiting time and average turnaround time using following scheduling algorithms.

v. FCFS

vi. SJF

vii. Priority (Preemptive)

viii. HRRN

Process	Arrival Time	Burst Time	Priority
A	0	3	5
B	2	6	4
C	4	4	1
D	6	5	3
E	8	2	2
F	3	4	1

3. a) Given five memory partitions of 100 KB, 500KB, 200KB, 300KB and 600KB (in order), how would the first-fit, best fit and worst-fit algorithms place processes of 212KB, 417KB, 112KB, and 426KB (in order)? Which algorithm makes the most efficient use of memory? Illustrate. 7

- b) Suppose a disk drive has 5500 cylinders, numbered 0 to 5499. The drive is currently serving a request at cylinder 2243 and the previous request was at cylinder 1125. The queue of pending requests in FIFO order is 8
586, 1470, 1913, 1774, 5348, 1509, 5022, 1750, 130
Starting from the current head position what is the total distance that the disk arm moves to satisfy all the pending requests for each of the following disk scheduling algorithms?
v. FCFS
vi. Closest Cylinder Next//SSTF
vii. C-Scan (Initially moving upward)
viii. Scan (Initially moving downward)
4. a) What is the difference between absolute and relative path name of a file? What criteria should be used to decide which strategy? (Contiguous, linked, indexed, allocation) is best utilized for a particular file? 7
b) List different classical IPC problems. Explain any one with algorithms.
5. a) Compare and contrast between virus and worm. Explain Access Control List (ACL) and Access Control Matrix (ACM). 7
b) Define Deadlock. What are the conditions and methods of handling deadlock? Explain 8
6. a) Define RAID. Explain with different level with diagrams. 7
b) Write the difference between logical and physical address. Describe about Coalescing and Compaction with suitable examples. 8
7. Write short notes on: (Any two) 2×5
a) The Shell
b) Types of Kernels
c) Kernel vs User mode

Exam Level Programme Year/Part	Final Internal Examination 2080		
B.E.	FM		100
Computer	PM	45	
II/III	Time	3 hrs	

Subject: Operating System

Candidates are required to give answers in their own words as far as practicable.
The figure in the margin indicates full marks.
Attempt all the questions

1. a) Define RTOS and MOS. Describe the two general views of an operating system and elaborate why these views are important. 8
- b) What is test-and-set instruction? How can it be used to implement mutual exclusion? Consider using a fragment of pseudo-assembly language aid on your explanation. 7
2. a) Differentiate between deadlock and starvation. For resources type with multiple instances, we can model resource allocation and requests as a directed graph connecting processes and resources. Explain the step involved in deadlock detection taking such graph as an example. 8
- b) What is the relationship between Thread and Process? Multi-programming (or multi-tasking) enables more than a single process to apparently execute simultaneously. How is this achieved on a uniprocessor? 7
3. a) Consider the Dining Philosophers problem with n philosophers but with n+1 forks; the extra fork is in the middle of the table and can be used by any philosopher (but only by one of them at a time). Is deadlock possible? Explain your answer. 7
- b) A set of processes with their respective arrival times and the length of their CPU burst are given below. Queue number denotes the queue of the process. Priority of Queue 1 is greater than Queue 2. Queue 1 uses Round Robin (Time Quantum = 2) and Queue 2 uses FCFS. 8

Process	Arrival Time	Burst Time	Queue Number
P1	0	4 2	1 greater [RR(2)]
P2	0	3 0	1 greater [RR(2)]
P3	0	8 5	2 - smaller [FCFS]
P4	10	5	1 greater [RR(2)]

Determine average-waiting time and average turn-around time using Multilevel queue scheduling.

4. a) Define page fault. A computer has four-page frame. The time of loading, time of last access, and the R and M bits for each page are shown below (the times are in clock ticks) 8

Page	Loaded	Last Reference	R	M
0	126	280	1	0
1	230	265	0	0
2	140	270	0	0
3	110	285	1	1

2nd, 1st
[P1] P2

Explain which page will NRU, FIFO, LRU and second chance page replacement algorithms replace?

- b) Explain the difference between internal and external fragmentation. Why should they be avoided? Explain the technique for overcoming these problems. 7
5. a) What are the reasons for not connecting I/O Devices directly to the system bus? What are the different I/O techniques? Differentiate programmed I/O and interrupt I/O techniques to each other. 8
- b) What is file system implementation? Explain Contiguous List and Linked List file system implementations with their relative advantages and disadvantages. 7

-- Best of luck --

Date: 2080/10/15	Level BE	Full Marks 50
Programme BCE		Time
Semester III		1.5 hrs

Subject: - Operating System

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt All questions.
- ✓ The figures in the margin indicate Full Marks.
- ✓ Assume suitable data if necessary.

1. Explain Producer Consumer Problem in process synchronization and give solutions to it. [7]
2. Define the critical section. The snapshot of the state is given below. Is this a safe state ? If yes, what is its safe sequence? [8]

Process	Max Allocation				Allocation				Available			
	A	B	C	D	A	B	C	D	A	B	C	D
P0	3	0	1	4	5	1	1	7	1	0	0	2
P1	2	2	1	0	3	2	1	1				
P2	3	1	2	1	3	3	2	1				
P3	0	5	1	0	4	6	1	2				
P4	4	2	1	2	5	3	2	5				

Need
MAX - Alloc

3. Draw a Gantt Chart and find average turnaround time and waiting time of the following process applying SJF, HRRN and Round Robin (quantum=3) scheduling algorithm. [8]

Process	A	B	C	D	E
Arrival Time	0.0	3.0	5.0	6.0	7.0
Burst Time	6	3	6	4	2

4. Consider the following page reference strings: 1, 3, 5, 3, 7, 1, 5, 3, 1, 2, 3, 7, 6, 3, 4, 1, 8. How many page faults would occur for each of the following page replacement algorithms assuming 4 pages a frame ? In each case calculate the fault ratio. [7]

- FIFO Page Replacement
- LRU Page Replacement
- Second Chance Page Replacement

5. Given five memory partitions of 200KB, 500KB, 200KB, 300KB and 600KB (in order), how would each of the first fit, best fit and worst fit algorithms place process of 212KB, 417KB, 112KB and 426KB (in order)? Which algorithm makes the most efficient use of memory ? [7]

6. Suppose the disk drive has 350 cylinders. The disk track requests are: 123, 250, 298, 120, 13, 300 and 224. Assume that the last request is at track 150. Find out the total seek time for each of the disk scheduling algorithms below:

- FCFS Define Virtual Memory. How does Paging solve the memory management problem?
- C-LOOK
- SCAN

7. Write short notes on: (Any two)

- DMA
- Thrashing
- Deadlock detection and recovery

[2.5*2=5]



Pokhara University
Everest Engineering College
Final Internal Assessment
Fall-2023

Level: Bachelor

F.M. 100

Program: BE CMP

P.M. 45

Faculty: Science & Technology

Time: 3hrs

Subject: Operating System (3rd Semester)

Attempt all the questions.

- 1 a) Explain the different structure of Operating System with diagrams.
 b) Illustrate different states of process with a neat diagram. The diagram should focus on 7 – state model.
- 2 a) Five batch jobs through A through E, arrive at a computer center at almost same time. They have estimated running times of 10, 6, 2, 4 and 8 minutes. Their priorities are 3,5,2,4 and 1 respectively. For each of the scheduling algorithms determine the average waiting time and average turn around time. Ignore process switching overhead.
 i. RR (quantum time = 2 minutes)
 ii. Priority Scheduling
 iii. SJF
- b) Consider a system with five processes P0 through P4 and three resources type A, B, C. Resource type A has 5 instances, B has 5 instances and type C has 4 instances. Suppose at time t0 following snapshot of the system has been taken:
 i. What is the content of the need matrix?
 ii. Is the system in safe state?

Process	Allocation			Max			Available		
	A	B	C	A	B	C	A	B	C
P0	0	3	1	3	3	1	1	0	1
P1	3	2	1	4	2	1			
P2	1	0	1	1	1	1			
P3	0	0	0	2	2	0			
P4	0	0	0	1	0	0			

- 3 a) What is semaphore? Explain the producer consumer problem and algorithm solving it using semaphore.
- b) Explain TLB briefly with necessary diagrams. Illustrate the concept of logical memory and physical memory.
- 4 a) What is page fault? Consider the following page reference strings: 2,3,3,4,5,6,5,7,1,2,5,8,6,4,1. How many page faults would occur for each of the following page replacement algorithms assuming 3 pages frames?
- i. LRU
 - ii. FIFO
 - iii. Optimal
- b) Explain the different attributes of file. Explain the file allocation techniques.
- a) What is the main purpose of DMA? Explain how does it works
- b) Explain Kernel and its types with suitable diagrams?
- a) Difference between Fixed sized Partition and Variable sized Partition?
- b) Explain about Threads and benefits of Multi-threading
- Write short notes on: (Any two)
- a) Race Condition
 - b) Paging Vs Segmentation
 - c) Distributed Operating System

Good Luck

SET -B

POKHARA UNIVERSITY
Semester Fall

Level: Bachelor
Programme: BE
Course: Operating System

Attempt all the questions

Year: 2024
Full Marks: 60
Pass Marks: 27

- 1) Explain briefly different types of Operating System along with their evolution. 8
- 2) What are the advantages of using Threads ? Explain how multiprocessor systems can be effectively utilized using threads? Explain with example. 7
- 3) State Producer Consumer Problem. Explain how can you solve producer consumer problem 7
- 4) How can Mutual Exclusion affect program performance ? Describe sleeping barber problem with pseudo code. 7

- 5) From the set of information, find the average waiting time and average turn around time using FCFS,SJF,RR(Quantum = 3) and HRRN. 7

Process	Arrival Time	Service Time (Burst Time)
A	0	7
B	2	6
C	4	8
D	7	5
E	9	4

- 6) Explain the architecture of Kernel. What is context switching between kernel mode and user mode? Explain. 8
- 7) Differentiate between external and internal fragmentation. How can you remove External fragmentation ? Explain. 7
- 8) Consider the following page reference strings: 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 each of the following page replacement algorithms assuming 3 pages a frame. In each case calculate fault ratio.
 i. FIFO
 ii. Second chance page replacement.
 iii. Optimal page replacement 8

SET -A

POKHARA UNIVERSITY Semester Fall

Level: Bachelor
Programme: BE
Course: Operating System

Year: 2024
Full Marks: 60
Pass Marks: 27

Attempt all the questions:

1. What is Operating System ? " Operating System acts as extended machine as well as resource manager" . Explain this statement with suitable example. 1
2. Differentiate between process and threads ? Explain the field in Process Control Block(PCB) 1
3. What is "Race Condition" ? What are its effect on the execution of the system ? Explain with example. 1
4. What are classical IPC problems ? Explain Reader- Writers Problem 1
5. From the set of information, find the average waiting time and average turn around time using FCFS,SJF,RR(Quantum = 3) and HRRN. 1

Process	Arrival Time	Service Time (Burst Time)
A	0	7
B	2	6
C	4	8
D	7	5
E	9	4

6. Explain different types of kernels in Operating System with their advantages and disadvantages. 8
7. What is thrashing ? How can you eliminate the problem of thrashing ? Explain. 7
8. Consider the following page reference strings: 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 each of the following page replacement algorithms assuming 3 pages a frame. In each case calculate fault ratio.
 - i. Second chance page replacement.
 - ii. LRU page replacement
 - iii. Optimal page replacement.

SET -C

POKHARA UNIVERSITY Semester Fall

Level: Bachelor
Programme: BE
Course: Operating System

Year: 2024
Full Marks: 60
Pass Marks: 27

Attempt all the questions:

What is Operating System ? "Operating System acts as extended machine as well as resource manager". Explain this statement with suitable example. 8

What are the advantages of using Threads ? Explain how multiprocessor systems can be effectively utilized using threads? Explain with example. 7

What is "Race Condition" ? What are its effect on the execution of the system ? Explain with example. 7

How can Mutual Exclusion affect program performance ? Describe sleeping barber problem with pseudo code. 8

From the set of information, find the average waiting time and average turn around time using FCFS,SJF,RR(Quantum = 3) and HRRN. 7

Process	Arrival Time	Service Time (Burst Time)
A	0	7
B	2	6
C	4	8
D	7	5
E	9	4

Explain the architecture of Kernel. What is context switching in terms of kernel mode and user mode? Explain. 8

What is thrashing ? How can you eliminate the problem of thrashing ? Explain. 7

Consider the following page reference strings: 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 each of the following page replacement 8

POKHARA ENGINEERING COLLEGE
Internal Assessment Examination

Level: Bachelor Semester - Fall Year :2022
 Programme: Computer Full Marks: 100
 Course: Operating System Pass Marks: 45
 Semester: III Time : 3hrs.

Candidates are required to give their answers in their own words as far as practicable.

The figures in the margin indicate full marks.

Attempt all the questions.

1. a) What are the functions of an operating system. How operating system creates abstraction? Explain with reference to OS as an extended machine. 4+4
- b) What is Process Control Block? Explain scheduling algorithm in real time operating system. 4+3
2. a) Consider following set of processes along with their burst time, arrival time and priorities. Calculate average waiting time and average turnaround time using following scheduling. 2+2+2
 i) FCFS ii) SJF iii) SRTF iv) RR (Quantum size = 4ms) +2

Process	Burst time	Arrival time
A	3 ✓	0
B	6 2	2
C	4 ✓	4
D	5 1	6
E	2 ✓	8

3. b) What is page table? Explain the structure of page table. 2+5
4. a) What do you mean by kernel? Explain types of kernel in brief. 2+5
- b) Explain the producer and Consumer Problem and its solution. 4+4
5. a) Explain interrupt driven I/O along with the disadvantage of programmed I/O. 7
- b) What is page fault? Consider the following page reference string:

1,2,3,4,2,1,5,6,2,1,2,3,✓,6,3,2,1,2,3,6. How many page faults would occur for the FIFO, optimal and LRU replacement algorithms having five frames? 8

5. a) Describe ACL in detail. Explain about I-node and file directory. 4+4
- b) Define deadlock and its causes. Explain deadlock prevention methods. 2+5
6. a) Define Distributed System. List out advantages and disadvantages of distributed system over centralized system. 5
- b) Describe concept of memory wall. What are the causes of memory bottlenecks. How can we address these causes? 2+4+4
7. Write short notes on any two: 2×5
 - a) RPC
 - b) Linked list allocation
 - c) Thread vs process

**GANDAKI COLLEGE OF ENGINEERING AND SCIENCE
INTERNAL ASSESSMENT**

Level: Bachelor
Programme: BE Computer
Course: Operating System

Semester: 3rd

Year : 2024
Full Marks: 100
Pass Marks: 45
Time : 3 hrs.

Candidates are required to give their answers in their own words as far as practicable.

The figures in the margin indicate full marks.

Attempt all the questions.

- a) Define Process. Explain different Operating System Structures. 8
- b) Differentiate between Process and Threads. Draw Five Stage Process state diagram and Explain in detail. 8
- a) What are Classical IPC Problems ? Provide solution to deadlock in Dining Philosophers problem. 8
- b) What are the necessary Characteristics of Deadlock ? Explain deadlock prevention and avoidance methods. 6
- c) What is Multi threading ? Explain different Thread Models and write two benefits of Multi threading. 6
- a) What is IPC ? Describe its implementation using Shared Memory and Message passing. 6
- b) Consider following set of processes along with their burst time, arrival time. Calculate average waiting time and average turnaround time using following scheduling algorithms. 6
 - i. FCFS
 - ii. SJF
 - iii. Round Robin (time quantum=3)

Process	Arrival Time	Burst Time
A	0	3
B	2	6
C	4	4
D	6	5
E	8	2
F	3	4

4. a) Explain the difference between Internal Fragmentation and External Fragmentation. 6
- b) Consider the following page reference string:
2,3,4,5,3,2,6,7,3,2,3,4,8,7,4,3,2,3,4,7. How many page fault will occur for each of the following 3 algorithms assuming 3 page frame per unit.
- i. Optimal
 - ii. LRU
 - iii. FIFO
5. a) Explain different types of kernels in detail.. 6
- b) Explain Contiguous and Non Contiguous memory allocation approaches with advantages and disadvantages. 6
6. a) Explain the concept of thrashing. Suggest ways to prevent it. 6
- b) Discuss the working principles Direct Memory Access. 6
- c) What is file system implementation ? Explain linked list and I-node file system implementation. 6
7. Write short notes on: (Any two) 10
- a) Distributed Operating System
 - b) Bankers Algorithm
 - c) Paging
 - d) RAID

NEPAL ENGINEERING COLLEGE

Changunarayan -4, Bhaktapur.

(Assessment Fall Semester 2024)

Level: Bachelor

Full Marks: 100

Programme: BE

Pass Marks: 45

Course: Operating System

Time: 3hrs.

Candidates are required to give their answers in their own words as far as practicable.

The figures in the margin indicate full marks.

Attempt all the questions.

1. a) Define an Operating System? Describe OS as an extended machine and resource manager. 8
- b) Explain different Process State with neat diagram. 7
2. a) What is a semaphore? Explain the producer consumer problems. Write the algorithm for producer consumer problems using semaphores. 8
- b) Explain the necessary conditions for deadlock occurrence and explain how it can be prevented. 7
3. a) What is context switching? Differentiate kernel mode and user mode? 7
- b) For the given process arriving at time zero, in the order given with the length of CPU burst time in millisecond 8

<u>Process</u>	<u>Burst Time</u>
P1	10
P2	29
P3	3
P4	7
P5	12

Consider the FCFS, SJF, and RR(Quantum = 10 m sec)

scheduling algorithm for this set of process. Which algorithm would give the maximum average waiting time?

4. a) What is swapping? Given Memory partition of 100k, 500k, 200k, 300k and 600k in order. How would first fit algorithm place processes of 212k, 417k, 112k and 426k in order? 8
- b) Consider the following page reference strings: 1, 3, 5, 3, 7, 1, 5, 3, 1, 2, 3, 7, 6, 3, 4, 1, 8. How many page faults would occur for each of the following page replacement algorithms assuming 4 pages a frames? 7
- i) LRU page replacement
 - ii) FIFO page replacement
 - iii) Optimal page replacement
5. a) Differentiate between contiguous and non-contiguous storage allocation 8
- b) Explain different file system implementation methods. 7
6. a) Define Distributed Operating System. How is it different from Network Operating system differentiate between them 8
- b) Describe different securities issues in an operating system 7
7. Short Notes (2 x 5) 10
- a) RAIDS
 - b) Banker's Algorithm
 - c) Memory wall and Bottleneck