CS & IT ENGINEERING

Operating System

CPU Scheduling

Lecture - 06

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Recap of Previous Lecture

Topic Multilevel Queue Scheduling

Topic Multilevel Feedback Queue Scheduling

Topic Questions on Scheduling

Topics to be Covered

Topic Questions on Scheduling

Topic Multithreading

Topic System Call: Fork()

[MCQ]

#Q. The arrival time, priority and duration of the CPU and I/O bursts for each of three processes P1, P2 and P3 are given in the table below. Each process has a CPU burst followed by an I.O burst followed by another CPU burst. Assume that each process has its own I/O resource.

Process	AT	Priority	BT (CPU)	BT(I/O)	BT(CPU)
P1	0	2	1	5	3
P2	2	3(lowest)	3	3	1
P3	3	1(highest)	2	3	1

The multi – programmed operating system uses preemptive priority scheduling. What are the finish times of the process P1, P2 and P3 ?

GATE - 2006

A 11, 15, 9

B 10, 15, 9

C 11, 16, 10

D 12, 17, 11

[MCQ]

Process	AT	Priority	BT (CPU)	BT(I/O)	BT(CPU)
P1	0	2	1	5	3
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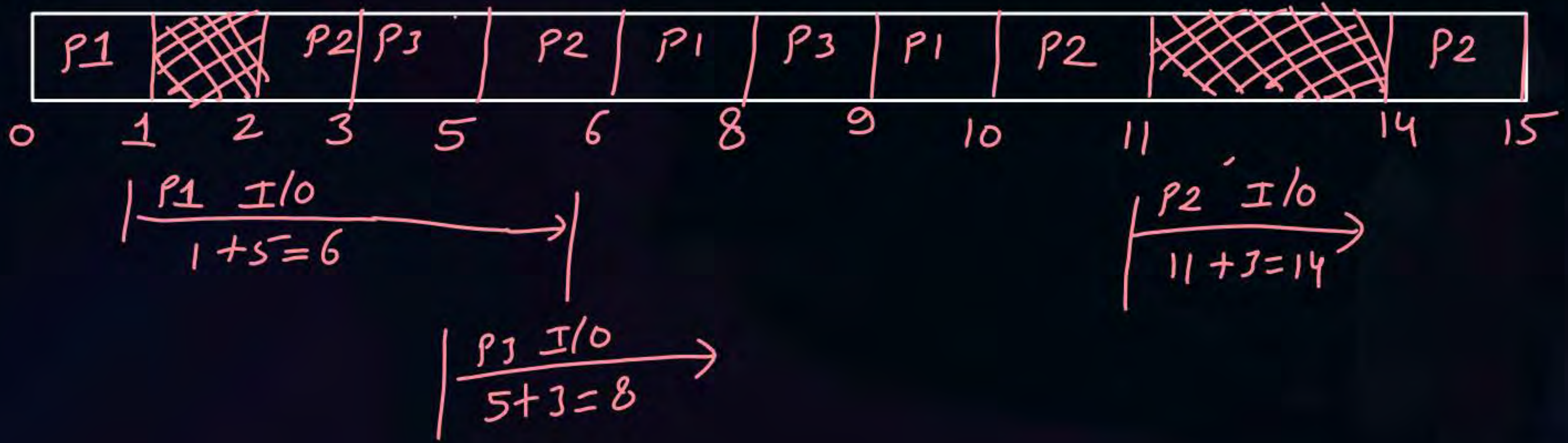


$$\% \text{ of CPU}^{\text{time}} \text{ idle} = \frac{4}{15} * 100\% = 26.67\%$$

$$\text{CPU utilization} = \frac{11}{15} * 100\% = 73.33\%$$

[MCQ]

#Q. Multilevel Queue Scheduling, with fixed priority preemptive algorithm

High ← Queue 1: RR with Q=2

Queue 2: SJF

P1	P4	P1	P4	P2	P3	P6	P7	P6	P5

0 2 4 5 7 10 15 17 19 20 24

Process	Arrival Time	Burst Time	Queue
P1	0	3	1
P2	1	3	2
P3	2	5	2
P4	1	4	1
P5	11	4	2
P6	15	3	1
P7	16	2	1

Queue 1: ~~P1~~, ~~P4~~, ~~P1~~, ~~P6~~, ~~P7~~, ~~P6~~

Queue 2: ~~P2~~, ~~P3~~, ~~P5~~

Topic : CPU Utilization

from gantt chart

1. ~~Without IO Operations~~ :-

$$\frac{\text{time unit for which CPU used}}{\text{Total execution time}}$$

2. With IO Operations :-

Assume a process can go for I/O 0.02 or 2% of time.

CPU utilization $= \underline{1} - 0.02$

$= 0.98$

Assume we have 2 processes with each having 2% I/O requirement

Fraction of time both processes will go for I/O $= 0.02 * 0.02$

$$= (0.02)^2$$

CPU utilization $= 1 - (0.02)^2$

---

for n no. of processes having I/O requirement $= p$

CPU utilization $= 1 - p^n$

[NAT]

Ans = 99.90

#Q. A computer system has degree of multiprogramming 10. And maximum IO wait, that can be tolerated is 0.5. The CPU utilization is ___ %?

$$= 1 - (0.5)^{10}$$

$$= 99.90\%$$

[NAT]

Ans = 2

#Q. Consider the following four processes with arrival times (in milliseconds) and their length of CPU bursts (in milliseconds) as shown below:

Process	P1	P2	P3	P4
Arrival time	0	1	3	4
CPU burst Time	3	1	3	Z

These processes are run on a single processor using preemptive Shortest Remaining Time First scheduling algorithm. If the average waiting time of the processes is 1 millisecond, then the value of Z is ________.

Gate - 2019

$$\text{avg. WT.} = \frac{\text{sum of WT of all processes}}{\text{no. of processes}} \Rightarrow \text{sum of WT} = 4\ \text{ms}$$

P1	0	~~3~~ ~~2~~ ~~0~~ ~~1~~
P2	1	~~0~~
P3	3	3
P4	4	2

	WT
P1	1
P2	0
P3	1 + 2 = 3
P4	0

P1	P2	P1	P4	P3	

0 1 2 4 6 9

[MCQ]

#Q. Consider n processes sharing the CPU in a round- robin fashion . Assuming that each process switch takes S seconds, what must be the quantum size q such that the overhead resulting form process switching is minimized but at the same time each process is guaranteed to get its turn at the CPU at least every t seconds ?

GATE - 1998

A $q \leq \frac{t-ns}{n-1}$

B $q \geq \frac{t-ns}{n-1}$

C $q \leq \frac{t-ns}{n+1}$

D $q \geq \frac{t-ns}{n+1}$

[MCQ]

#Q. A uni-processor computer system only has two processes, both of which alternate 10 ms CPU bursts with 90 ms I/O bursts. Both the process were created at nearly the same time. The I/O of both processor can proceed in parallel. Which of the following scheduling strategies will result in the least CPU utilization (over a long period of time) for this system ?

GATE - 2003

A. First come first served scheduling

B. Shortest remaining time first scheduling

C. Static priority scheduling with different priorities for the two processes

D. Round robin scheduling with a time quantum of 5 ms.

[MCQ]

#Q. Consider three processes, all arriving at time zero, with total execution time of 10, 20 and 30 units, respectively. Each process spends the first 20% of execution time doing I/O, the next 70% of time doing computation, and the last 10% of time doing I/O again. The operating system uses a shortest remaining compute time first scheduling algorithm and schedules a new process either when the running process gets blocked on I/O or when the running process finishes its compute burst. Assume that all I/O operations can be overlapped as much as possible. For what percentage of time does the CPU remain idle?

GATE - 2006

A. 0%

B. 10.6%

C. 30.0%

D. 89.4%

[NAT]

#Q. Consider a uniprocessor system executing three tasks T_1,T_2 and T_3 each of which is composed of an infinite sequence of jobs (or instances) which arrive periodically at intervals of 3, 7 and 20 milliseconds, respectively. The priority of each task is the inverse of its period, and the available tasks are scheduled in order of priority, which is the highest priority task scheduled first. Each instance of T_1, T_2 and T_3 requires an execution time of 1, 2 and 4 milliseconds, respectively. Given that all tasks initially arrive at the beginning of the 1st millisecond and task preemptions are allowed, the first instance of T_3 completes its execution at the end of milliseconds.

GATE - 2015

[MCQ]

#Q. Consider four processes P, Q, R, and S scheduled on a CPU as per round-robin algorithm with a time quantum of 4 units. The processes arrive in the order P, Q, R, S, all at time t = 0. There is exactly one context switch from S to Q, exactly one context switch from R to Q, and exactly two context switches from Q to R. There is no context switch from S to P. Switching to a ready process after the termination of another process is also considered a context switch. Which one of the following is NOT possible as CPU burst time (in time units) of these processes? **GATE-2022**

(A) P = 4, Q = 10, R = 6, S = 2

(B) P = 2, Q = 9, R = 5, S = 1

(C) P = 4, Q = 12, R = 5, S = 4

(D) P = 3, Q = 7, R = 7, S = 3

P

Q

R

S

P	Q	R	S	Q	R	Q	

0

BT

$P \Rightarrow 1$ time $\Rightarrow \leq 4$

$Q \Rightarrow 3$ times $\Rightarrow 9 \leq BT \leq 12$

$R \Rightarrow 2$ times $\Rightarrow 5 \leq BT \leq 8$

$S \Rightarrow 1$ time $\Rightarrow \leq 4$

✓ $S \longrightarrow Q \Rightarrow 1$

✓ $R \longrightarrow Q \Rightarrow 1$

✓ $Q \rightarrow R \Rightarrow 2$

✗ $S \rightarrow P \Rightarrow$ ✗

Topic : Multithreading

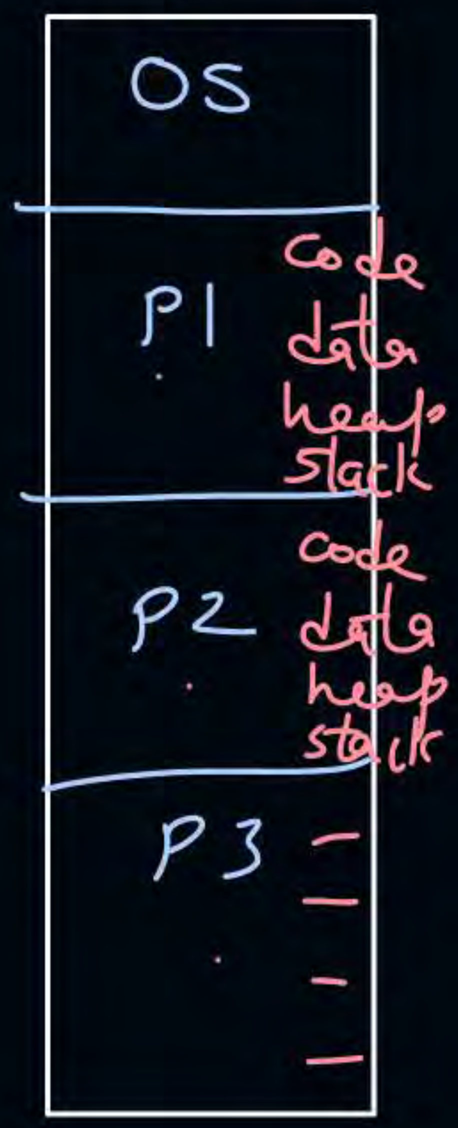
Thread :-

Component of process

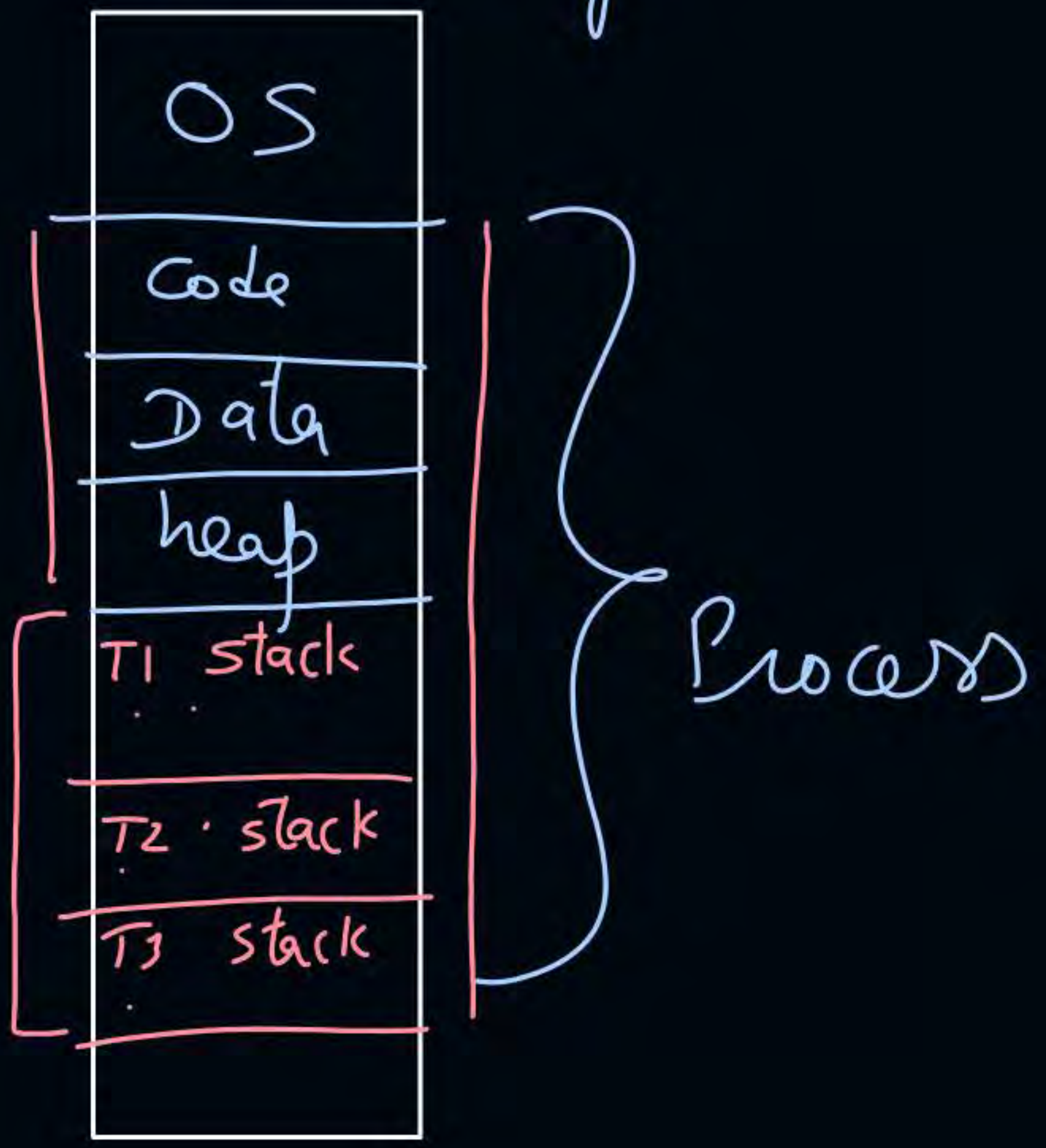
or

Lightweight Process

Provide a way to improve application performance through parallelism copy of same process



multithreading

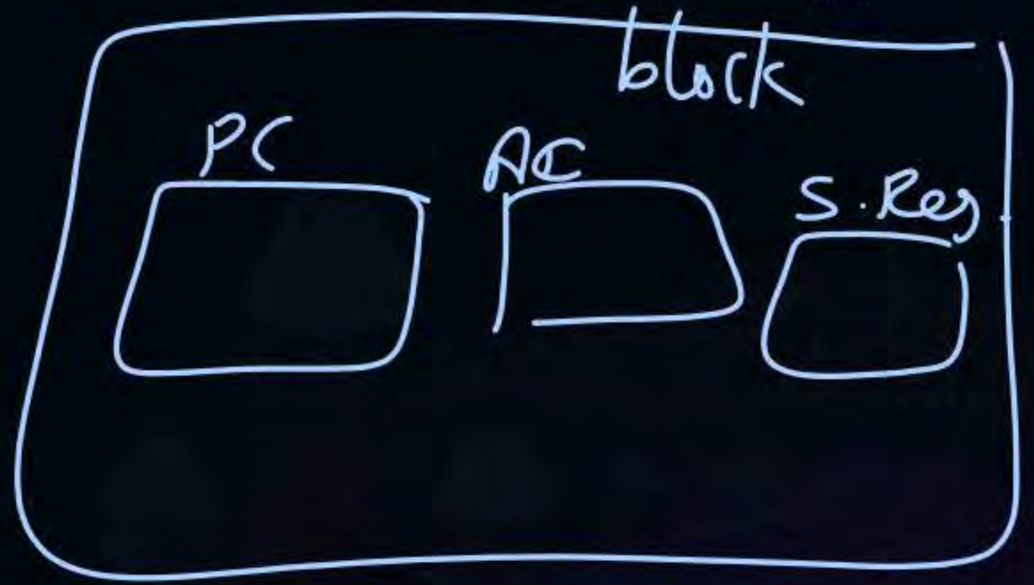


Topic : Threads

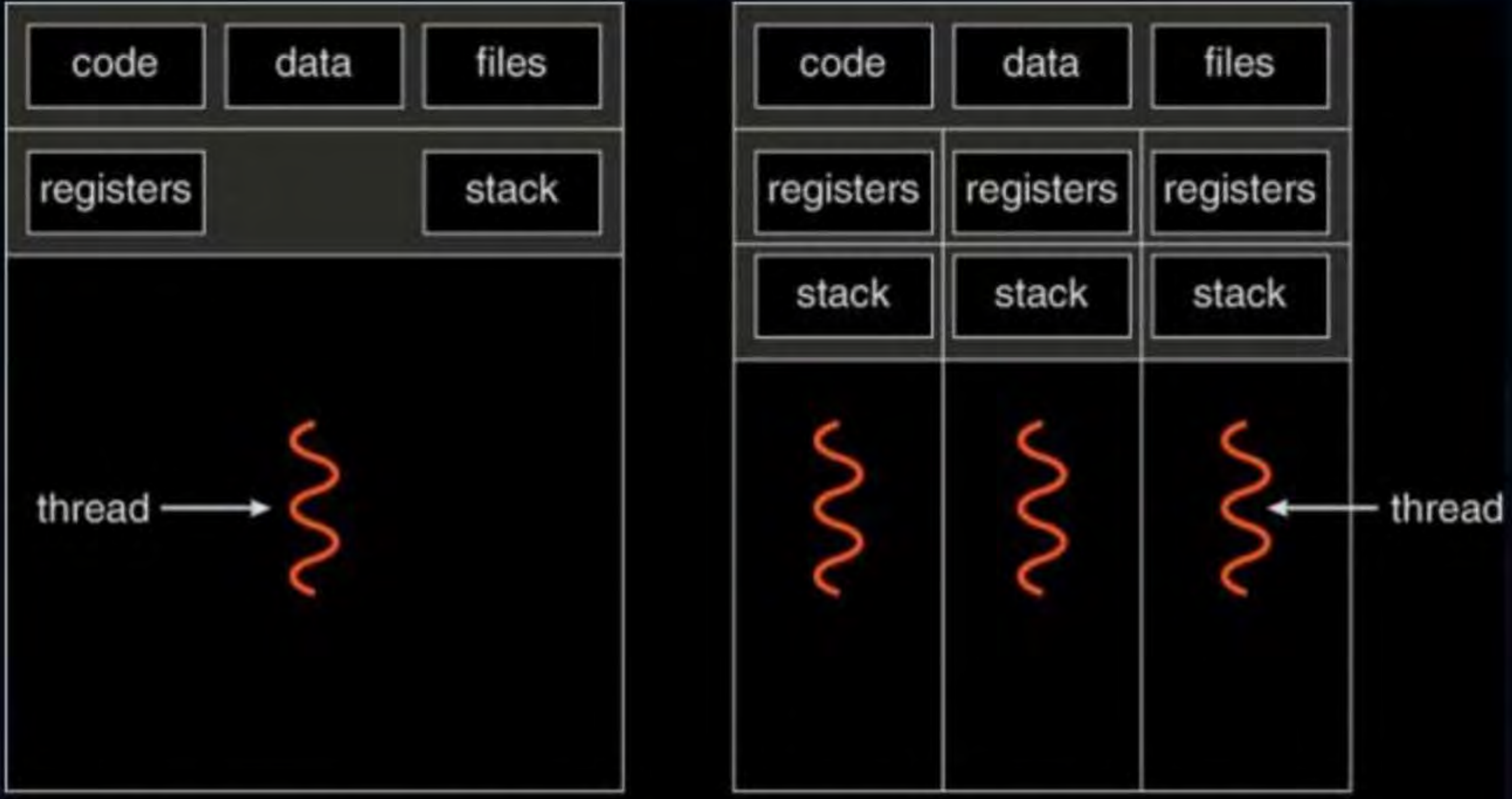
PCB

Shared Among Threads	Unique For Each Thread
Code Section	Thread Id
Data Section	Register Set
OS Resources	Stack
Open Files & Signals	Program Counter
Heap	

TCB Thread Control block



Topic : Threads



single-threaded process

multithreaded process

Topic : Advantages of Multithreading

- Responsiveness
- Faster Context Switch
- Resource Sharing
- Economy
- Communication
- Utilization of Multiprocessor Architecture

Topic : Types of Threads

1. User Level Thread
2. Kernel Level Thread

Topic : Types of Threads

User Threads	Kernel Thread
Multithreading in user process	Multithreading in kernel process
Created without kernel intervention	Kernel itself is multithreaded
Context switch is very fast	Context switch is slow
If one thread is blocked, OS blocks entire process	Individual thread can be blocked
Generic and can run on any OS	Specific to OS
Faster to create and manage	Slower to create and manage

2 mins Summary

Topic — Questions on Scheduling

Topic — Multithreading

Topic — System Call: Fork()

Happy Learning

THANK - YOU