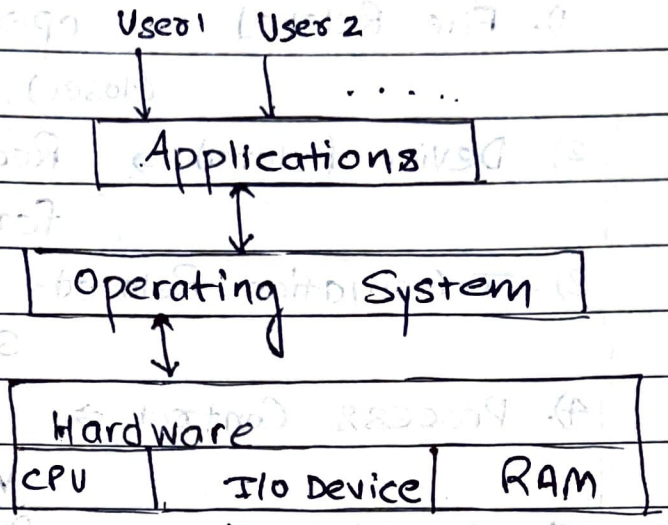
Introduction to Operating System and its functions.



- Convenience
- Throughput

Functions :-

1). Resource Management
2). Process Management (CPU Scheduling)
3). Storage " (HD)
4). Memory " (RAM)
5). Security

Multiprogrammed OS (Non preemptive)
↳ IDLENESS
↳ Execute first process, then only switch to second completely

Multitasking OS / Time Sharing OS :-
↳ Responsiveness
Execute task on the basis of slots.

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"System Call"

1). File Related ⇒ open(), Read(), Write(), Close(), createfile, etc.

2). Device Related ⇒ Read, Write, Reposition, ioctl, fcntl.

3). Information Related ⇒ get Pid, attributes, get System time & data

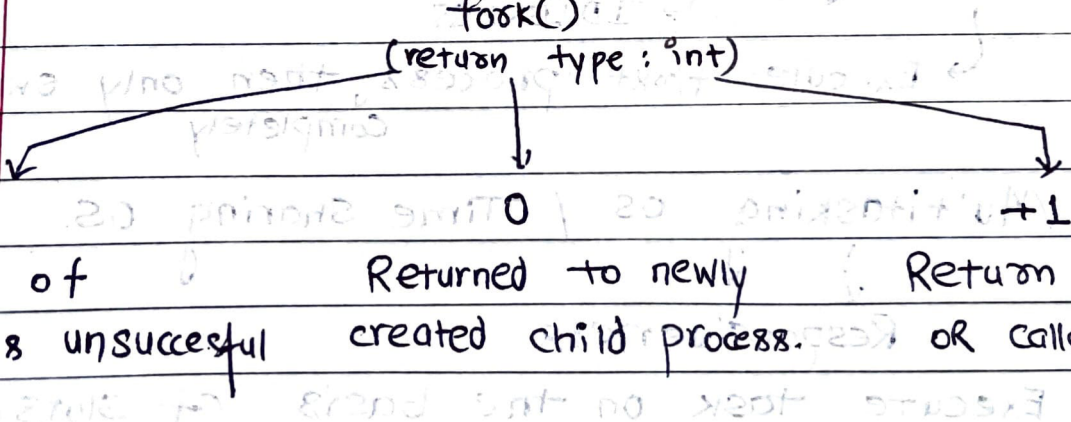
4). Process Control ⇒ Load, Execute, Abort, For Wait, Signal, Allocate, etc

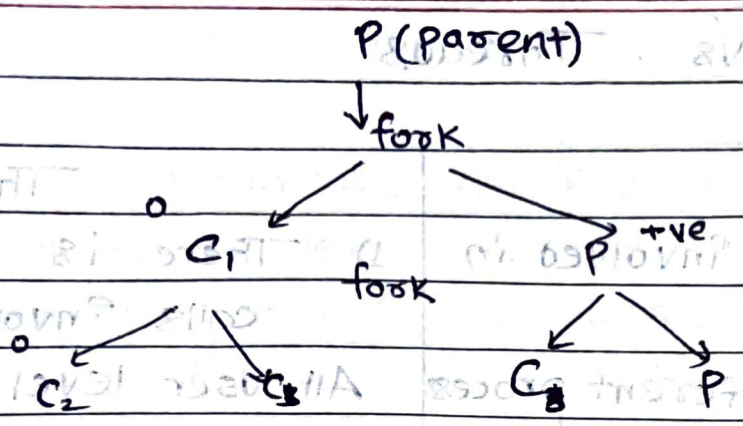
5). Communication ⇒ Pipe(), Create/delete Conn Shmget()

"Fork"

Fork System Call is used for creating new process, which is called child process, which runs concurrently with the process that m the fork() call.

A child process uses same PC (program counter same CPU registers,



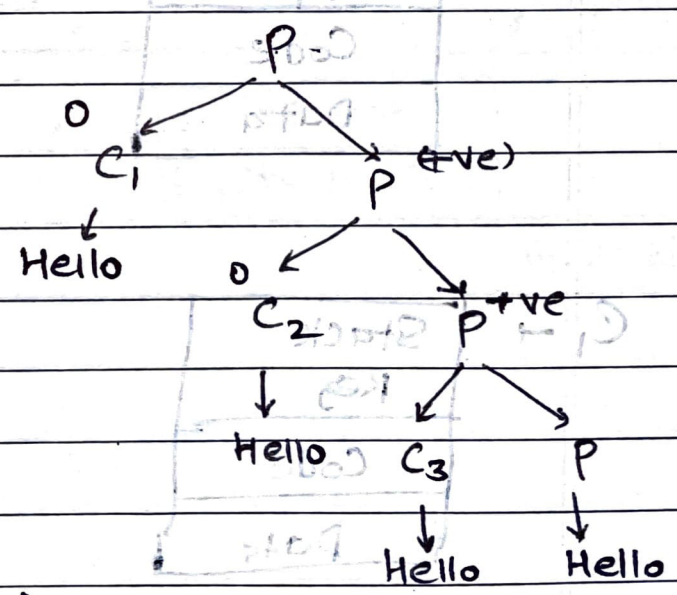


Question On Fork

Q.1.

```
int main()
{
    if (fork() && fork())
        fork();
    print("Hello\n");
    return 0;
}
```

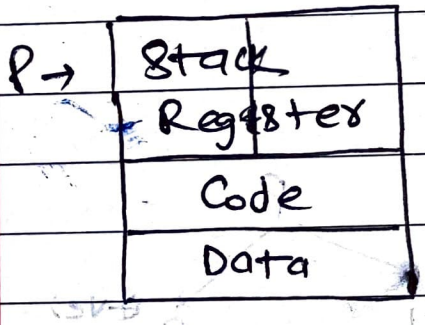
(total will be 0)

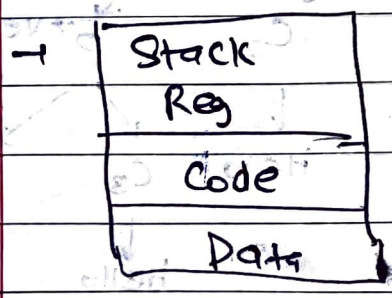


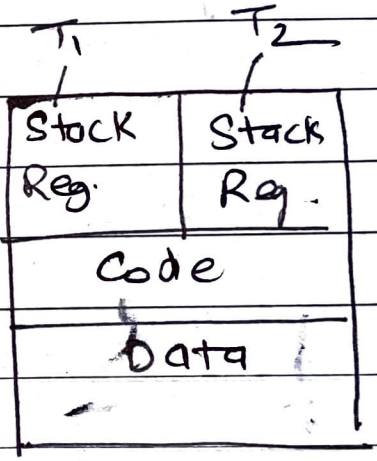
Soln → Hello (4 times)

Process Vs Threads

Process	User level Threads
System Calls involved in the process	1). There is no system calls involved
OS treat different process differently	All user level threads treated as single task for OS
Different process have diff. copies of data, file, codes.	Threads share same copy of data and code
Context switching is slower	Context switching is faster
Blocking a process will not block another	Blocking a thread will block entire process
~~Interdep~~ Independent	~~Interdependent~~

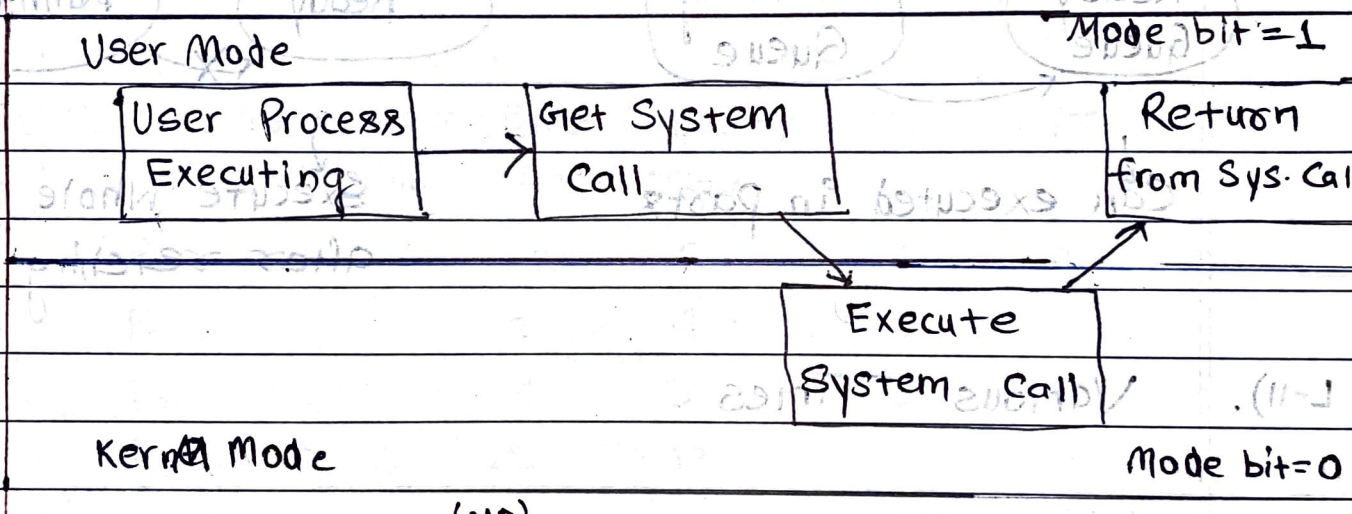






User level Thread.	Kernel level Thread
1). User level threads are managed by User level library	• Kernel level threads are managed by OS.
2). User level threads are typically fast.	• Kernel level threads are slower than User level.
3). Context Switching is fast.	• Context Switching is slow
4). If one user level thread perform blocking operation then entire process gets blocked.	• If one Kernel level thread blocked, no affect on others

User Mode Vs Kernel Mode



(HD)

Scheduling Algorithms

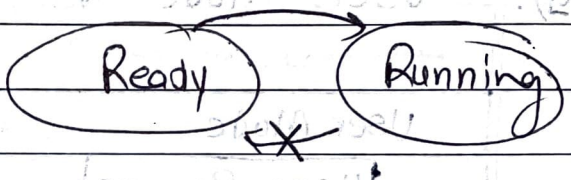
Pre-Emptive

- SRTF (Shortest Remaining time first)
- LRTF (Longest Remaining time first)
- Round Robin
- Priority based

Non Pre-Emptive

- FCFS (First Come First Serve)
- SJF (Shortest Job First)
- LJF (Long Job First)
- HRRN (Highest Response Ratio Next)
- Multilevel Queue
- Priority based

Can executed in parts



Execute whole process after reaching Running

Various Times

ARRIVAL Time : The time at which process enter the ready Queue.

BURST Time : Time Required by a process to get executed on CPU.

Completion Time : The Time at which process complete its execution.

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Turn Around Time :
{ Completion Time - Arrival Time }

Waiting Time :
{ Turn Around Time - Burst Time }

Response Time :
{ Time at which a process get CPU first time — Arrival time }

CPU Scheduling Algorithm -->

- First Come First Serve (FCFS)

Criteria : "Arrival Time"

Mode : "Non-Preemptive"

Process No	Arrival time	Burst Time	Completion Time	TAT	WT	RT
P_1	0	2	2	2	0	0
P_2	1	2	4	3	1	1
P_3	5	3	8	3	0	0
P_4	6	4	12	6	2	2

Gran++ Chart

Avg. Wating Time = $\frac{3}{4}$

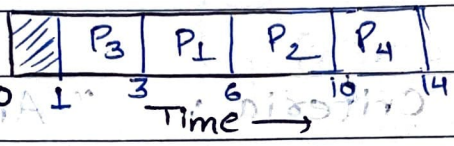
- Shortest Job First (SJF) Algorithm

Criteria : "Burst Time"

Mode : Non-Preemptive

Process No	Arrival Time	Burst Time	Completion Time	TAT	WT	RT
P_1	1	3	6	5	2	2
P_2	2	4	10	8	4	4
P_3	1	2	3	2	0	0
P_4	4	4	14	10	6	6

Grantt Chart



P_1, P_3 — both arrived at 1.

Burst time of P_3 is smaller So P_3 will be selected.

Now P_1 P_2 will be in the ready Queue at 3.

Burst time (P_1) < Burst time (P_2)

Now P_2 P_4 → Burst time Same

So select on the basis of arrival time

In Non-preemptive Response time == WT

Average Turn Aroud Time

$$= \frac{5+8+2+10}{4}$$

$$= 6.25$$

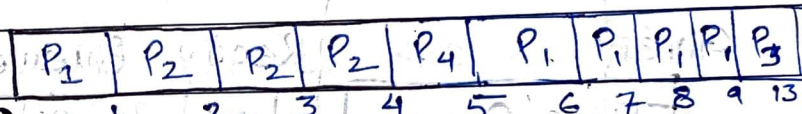
Avg WT = 3

- Shortest Remaining Time First (SRTF)

Criteria : "Burst Time"
Mode : "Preemptive"

Process No	Arrival Time	Burst Time	Completion Time	TAT	WT	RT
P_1	0	5	9	9	4	0
P_2	1	3	4	3	0	0
P_3	2	4	13	11	7	7
P_4	4	1	5	1	0	0

Grantt Chart



At 0 → P_1 (4)
At 1 → P_1 P_2 (4,3)
At 2 → P_1 P_2 P_3 (4, 2, 4)
At 3 → P_1 P_2 P_3 (4, 1, 4)
At 4 → P_1 P_3 P_4 (4, 4, 1)
At 5 → P_1 P_3 (4, 4) → Now Arrival

Avg. Waiting Time $= \frac{24}{4}$

$= 6$

Avg. Response Time $= \frac{7}{4}$

• Round Robin (RR) CPU scheduling Algorithm

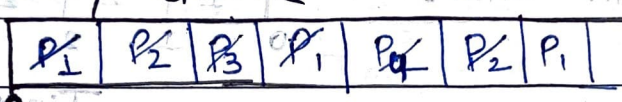
Criteria : "Time Quantum"

Mode : "Preemptive"

Process No	Arrival Time	Burst Time	Completion Time	TAT	WT	RT
P_1	0	5	12	12	7	0
P_2	1	4	11	10	6	1
P_3	2	2	6	4	2	2
P_4	4	1	9	5	4	4

Time Quantum
TQ = 2

Ready Queue



Running Queue (Gantt Chart)

Context Switching
(Sending Running Process back to Ready Queue and loading new Program)

How

Context Switching at (2, 4, 6, 8, 9, 11)

No. of Context Switching = 6

• Preemptive Priority Scheduling Algorithm :

Criteria : "Priority"
Mode: "Preemptive"

Priority	Process No	Arrival Time	Burst Time	Completion Time	TAT	WT	RT
10	P_1	0	5	12	12	7	
20	P_2	1	4	8	7	3	
30	P_3	2	2	4	2	0	
40	P_4	4	1	5	1	0	

Higher the Value (Priority) - higher the priority

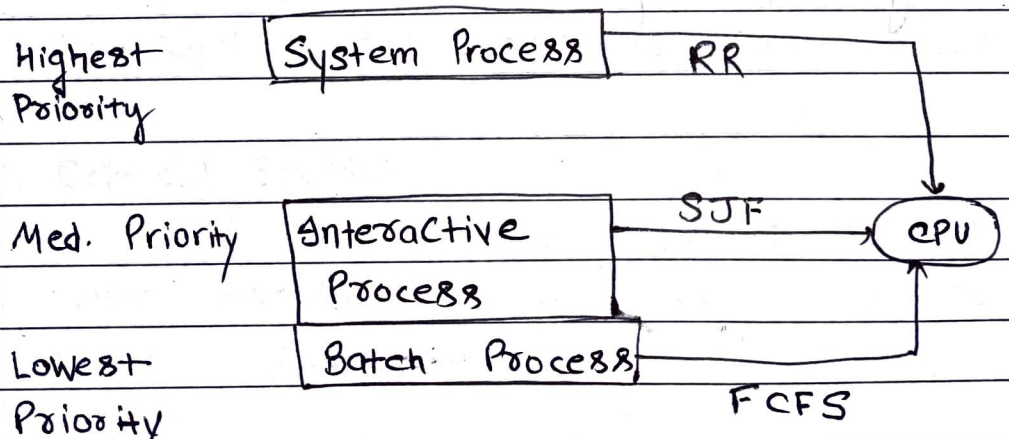
Grantt Chart

P_1	P_2	P_3	P_3	P_4	P_2	P_2	P_2	P_1	P_1

0 1 2 3 4 5 6 7 8 12

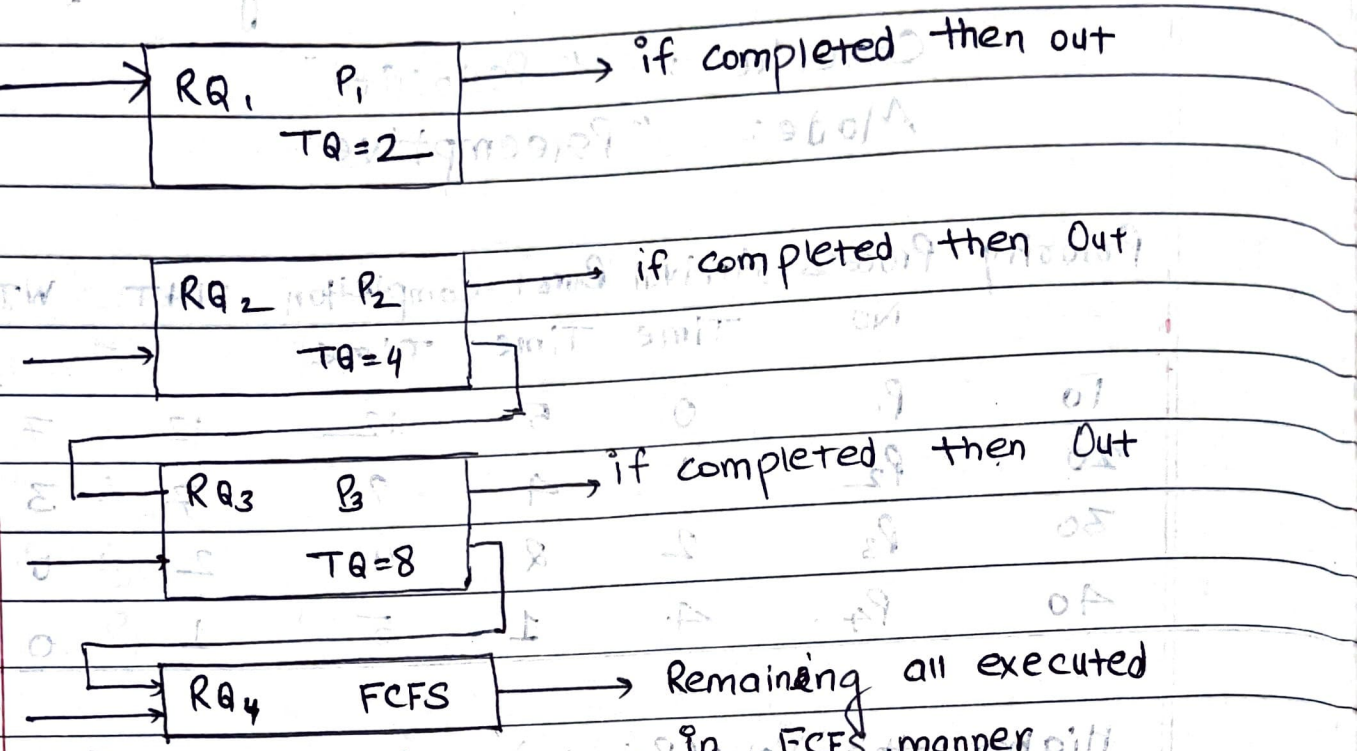
Time	P_1	P_2	P_3	P_4
	5 4	4 3	2 1	1

Multi Level Queue Scheduling



Due to priority — Starvation

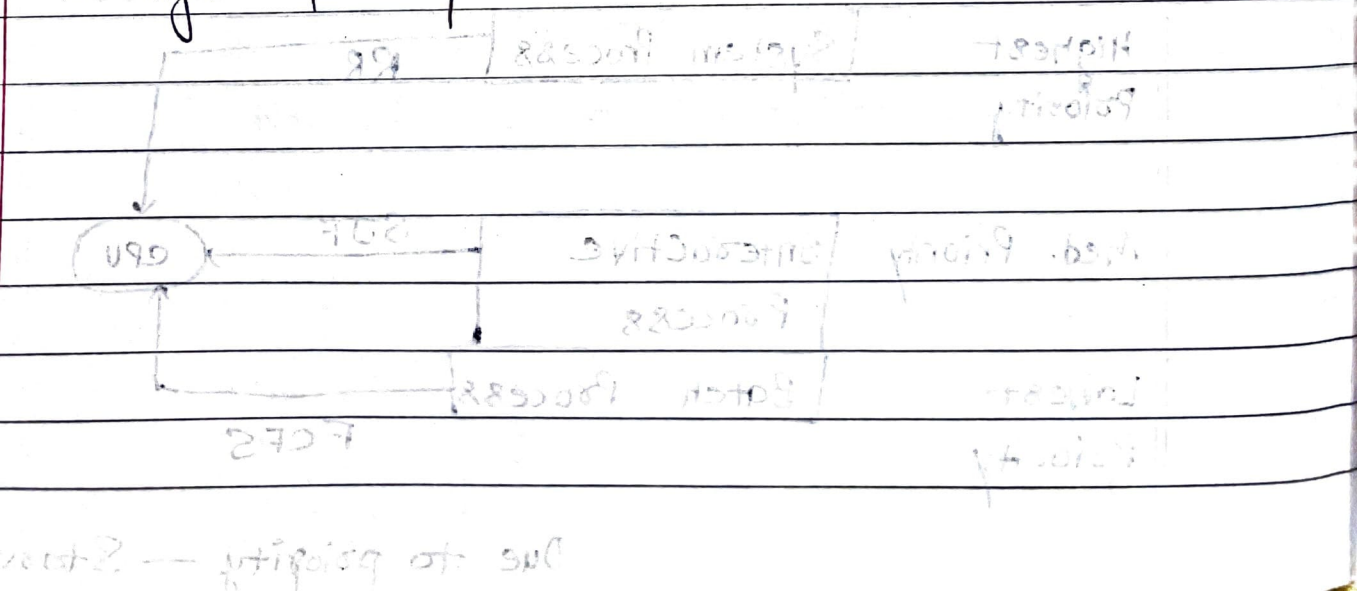
Multilevel Feedback Queue Scheduling



Assume P_1 = 19 (takes 19 unit to execute)

RQ_1	~~19~~	17
RQ_2	~~17~~	13
RQ_3	~~13~~	5
RQ_4	~~5~~	0

So the process will get executed for Time-Quantum TQ and if not completed then passed on to higher priority Queue.



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L-20). # Process Synchronization

Process

Cooperative Process
(Execution of one depends on other processes)

Independent Process
(Execution of one process is independent of others)

They share something

a). Variable
b) Memory

c). Code
d). Resources (CPU, Printer)

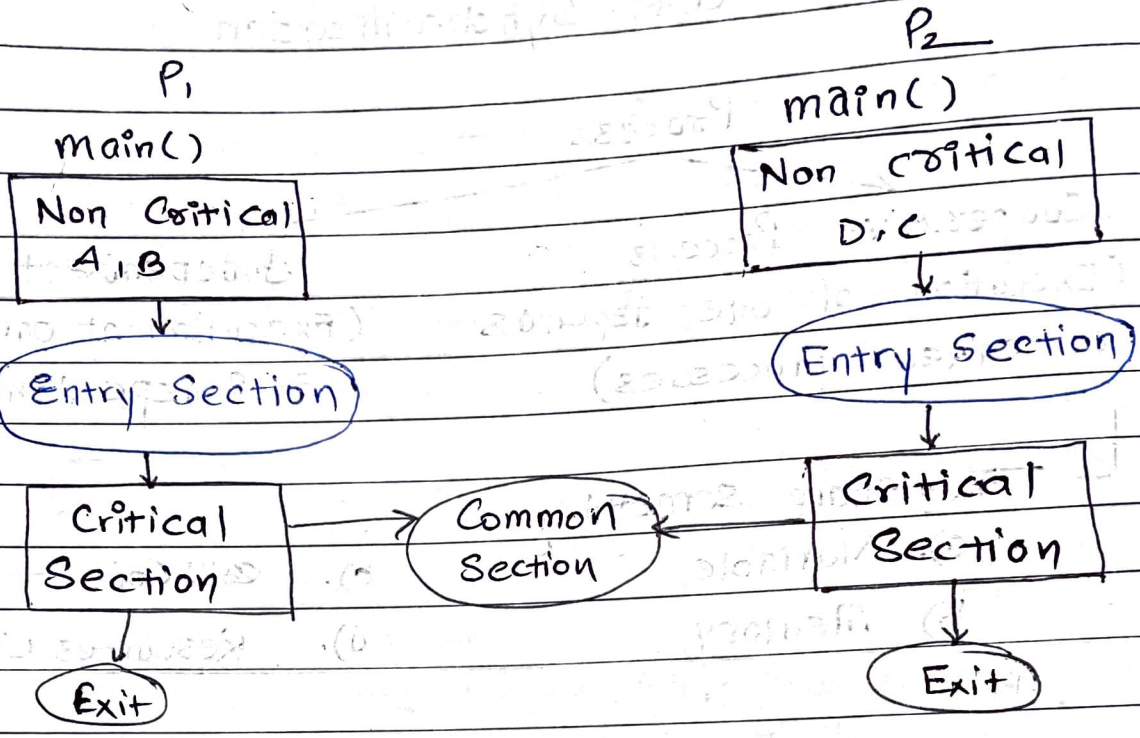
```
int shared = 5;

P1                          P2
int y = shared              int x = shared;
y++  → 6                    x = 4
sleep(1)                    sleep(1);
shared = y;                 shared = x
shared = 6                  shared = 4
```

This is called Race Condition. So, synchronization is required to overcome this problem.

L-21). **Critical Section** :

It is part of the program where shared resources are accessed by various processes.



→ Synchronization Mechanism

4 Conditions

Primary
1). Mutual Exclusion
2). Progress

Secondary
3). Bounded Wait
4). No assumptions related to H/W speed.

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L-22). Producer Consumer Problem

```
                                    n = 8
                                    Buffer
void consumer(void)                                  int count=0
{ int itemc;                    0   x1               void Producer (void)
  while(true)                   1   x2               { int item;
{                               2   x3                 while(true)
  while(count==0)               3   x4               { produce_item(item);
itemC= Buffer(Out);             4                      While (count==n);
Out=(Out+1) mod n               5                      Buffer[in]=item;
count=count-1;                  6                      in=(in+1) mod n;
}                               7                      count=count+1;
}                                                    }
                                                     }
```

```
load Rc, m[count]          1.  load Rp, m[count]
DECR Rc                    2.  INCR Rp
Store m[count], Rc         3.  Store m[count], Rp
```

If all these instructions are executed in seq. then they will produce correct result.
But if

Producer I_1 I_2 Consumer I_1 I_2 Producer I_3 Consumer I_3

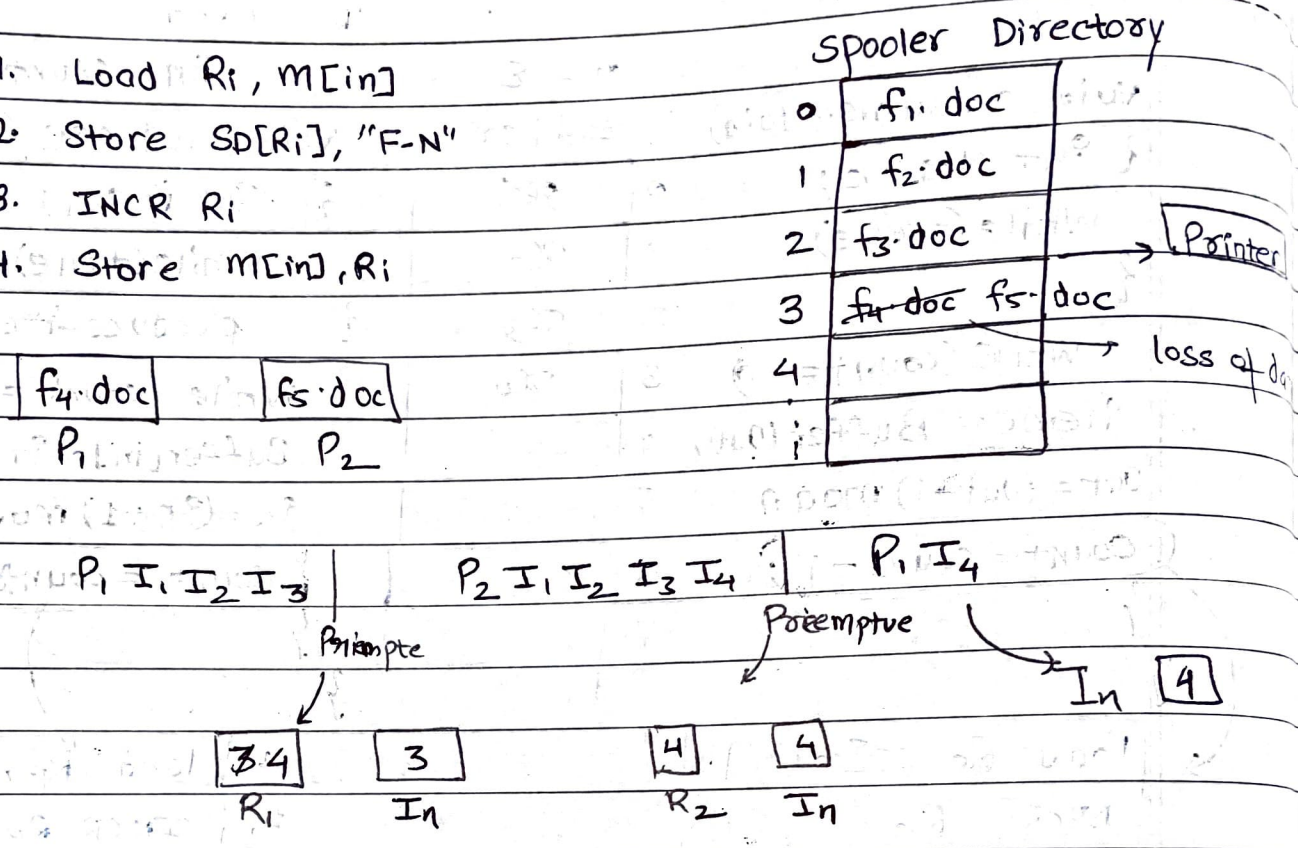
In: 3 | 4 → Count: 3 4 | 2 → R_{Dutum}: 3 | 4

But count = 3

Wrong Result ☹

L-23). Printer - Spooler Problem

1. Load Ri, m[in]
2. Store SD[Ri], "F-N"
3. INCR Ri
4. Store m[in], Ri



So there is loss of data at m[3].

L-24). Semaphore

- Counting ($-\infty$ to $+\infty$)
- Binary (0, 1)

Semaphore is an integer variable which is used in mutual exclusive manner by various concurrent cooperative processes in order to achive synchronization.

P(), Down(), Wait() ⟹ Entry Section

CS

V(), Up(), Signal / Post / Release ~~Exit~~

Interprocess Communication and

→ Synchronization is a technique which is used to cooperate the processes that uses shared Critical Section : It is the part of the program where shared resources are accessed by process

- Requirement of Synchronization mechanism

Primary

a). Mutual Exclusion : If one process is in CS then no ~~one~~ other process can enter into CS.

b). Progress : When no process is in CS, then any process from outside that request for ~~requ~~ execution can enter into CS without any delay.

Secondary

c). Bounded Waiting : An upper bound must exist on the number of times a process enters so that other process can enter.

d). No assumption of hardware speed and all

Synchronizatio Mechanism

Busy Waiting (Continuously Knock until open the door)

No Busy Waiting (Get to sleep)

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a). Lock Variable :

Busy Waiting Solution

Can be used even for more than two process

```
Entry section   1.  while (LOCK != 0) ;
                2.  LOCK = 1

data.

                3.  Critical section

Exit            4.  LOCK = 0 ;
```

Here many process can enter into CS at same time. Hence, mutual exclusion is not satisfied.

Ex: P_1 comes seen that tag shows vacant but at the same time P_1 gets preempted and P_2 comes checks that tag is vacant, so P_2 enters into CS and change the tag to occupied and after some time when P_1 comes back it executes remaining steps i.e., enters into CS without looking for tag again.

P_1 : 1	P_2 : 1,2,3,	P_1 : 2, 3

↑ Both enter.

b). TSL (Test Set lock)

1. LOCK: LOCK, R0
2. CMP R0, #0
3. JNZ Step 1
4. Store #1, LOCK (Lock Variable)

Here flag is used and preemption is removed the above issue.

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It ~~setest~~ and set the memory location value to 1 as a single atomic operation.
i.e., if one process is executing a test and set, no process is allowed to begin another test and set.

This synchronization characteristics :

i). It ensures mutual exclusion
ii). It is deadlock free.
iii). It doesn't guarentee bounded wait.
iv. It suffers spin lock.

Priority Inversion :
If P_1 is executing and some other process P_2 with higher priority comes, then CPU will favour P_2 but our synchronization mechanism will not allow P_2 to enter into CS, so there is spin lock.

Strict alternation Approach OR Turn Variable

- Busy Waiting solution
- 2-Process solution

Progress (X)

P_0

Non CS
→ while (turn != 0);
CS
→ turn = 1;
Non CS

Mutual exclusion (✓)

P_1

Non CS
while (turn != 1);
CS
turn = 0;
Non CS