Amirkabir University of Technology
(Tehran Polytechnic)

Operating Systems

CPU Scheduling-Part2

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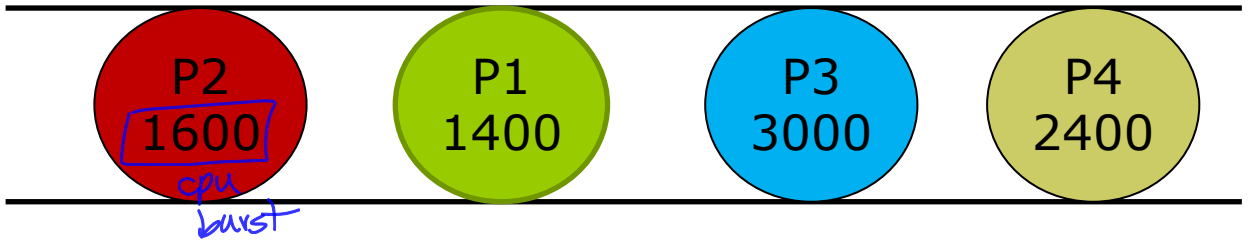
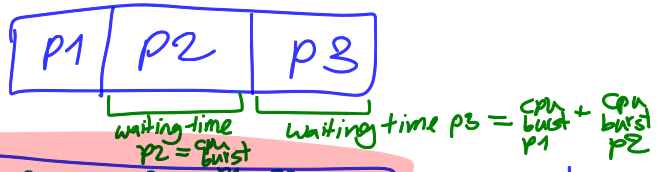
Shortest-Job-First (SJF) Scheduling

- **Associate** with each process the length of its **next CPU burst**.
  - Use these lengths to schedule the process with the shortest time.

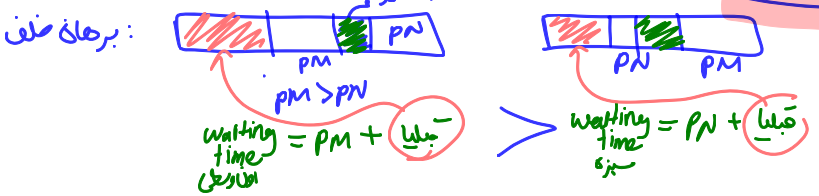


Shortest-Job-First (SJF) Scheduling (cont.)

- **SJF is optimal**
  - **Gives minimum average waiting time** for a given set of processes.



- Preemptive version called **shortest-remaining-time-first**

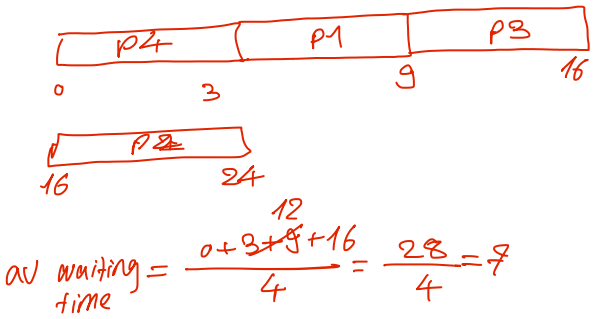


- **The difficulty is knowing the length of the next CPU request**
  - Could ask the user
  - Estimate (we do not cover this in the class and the exams)

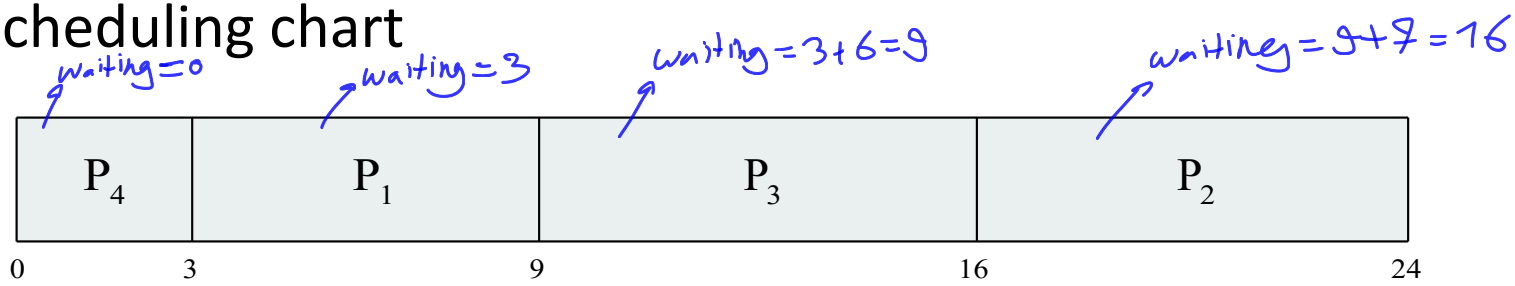
Example of SJF

non-preemtive

Process	Burst Time
P_1	6
P_2	8
P_3	7
P_4	3



- SJF scheduling chart



- Average waiting time = (3 + 16 + 9 + 0) / 4 = 7

Round Robin (RR)

دوره‌ای چرخشی

- **Each process gets a small unit of CPU time (time quantum q)**
  - Usually 10-100 milliseconds.
  - After this time has elapsed, the process is preempted and added to the end of the ready queue.

⇓ preemtive!

- **If there are n processes in the ready queue and the time quantum is q:**
  - Each process gets 1/n of the CPU time in chunks of at most *q* time units at once.
  - No process waits more than *(n-1)q* time units. → قابل اثبات ریاضی

هیچ وقت مشکل starvation نداریم. یعنی الگوریتم نداره خوبیت به اجرای برنامه‌های تعاملی

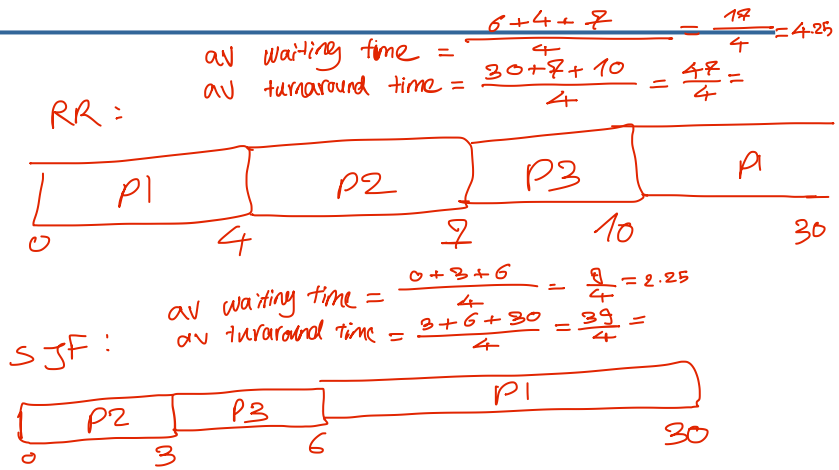
Round Robin (RR) (cont.)

- Timer *interrupts* every quantum to schedule next process
- Performance
  - *q* large ⇒ FIFO (like CFS) ⇒
  - *q* small ⇒ *q* must be large with respect to context switch,

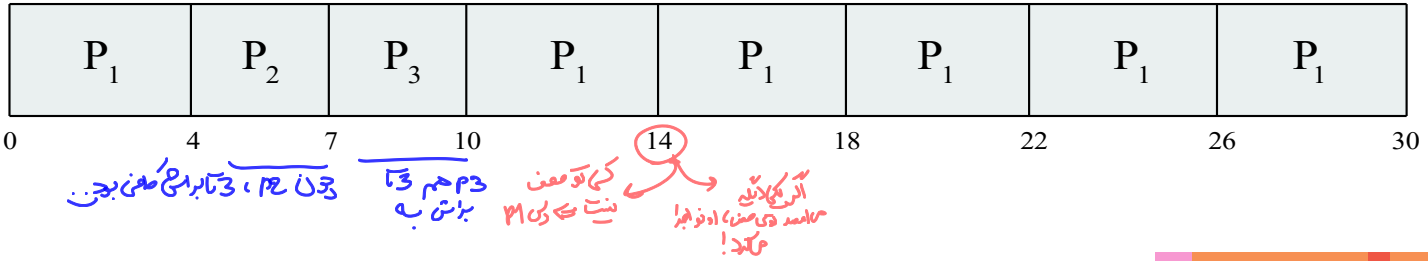
    otherwise overhead is too high

Example of RR with Time Quantum = 4

Process	Burst Time
P_1	24
P_2	3
P_3	3

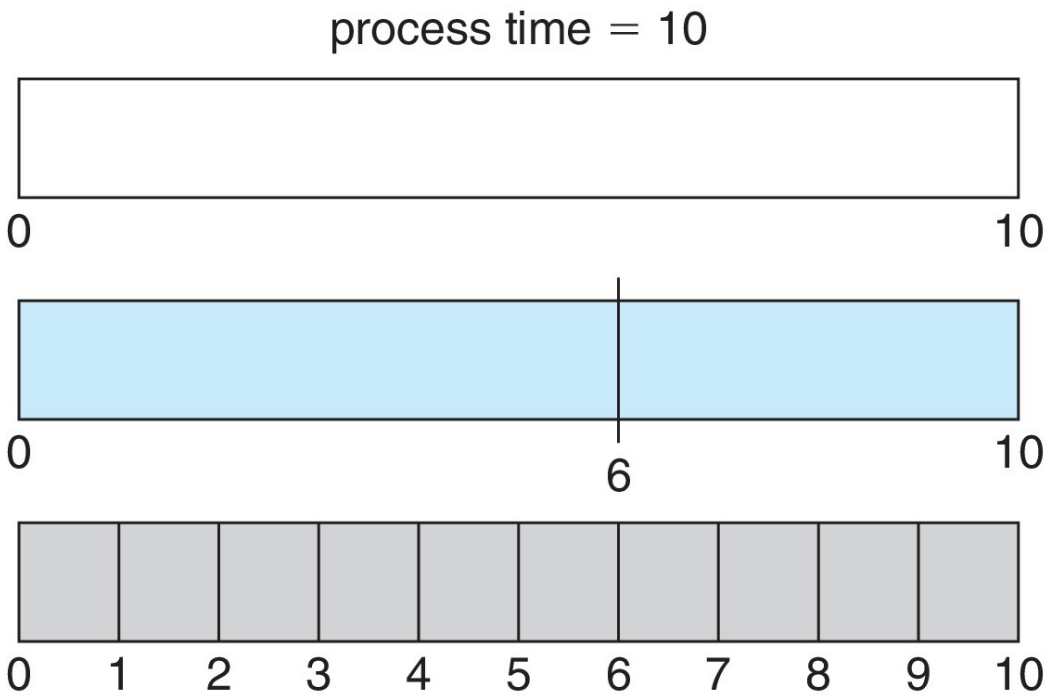


- The Gantt chart is:



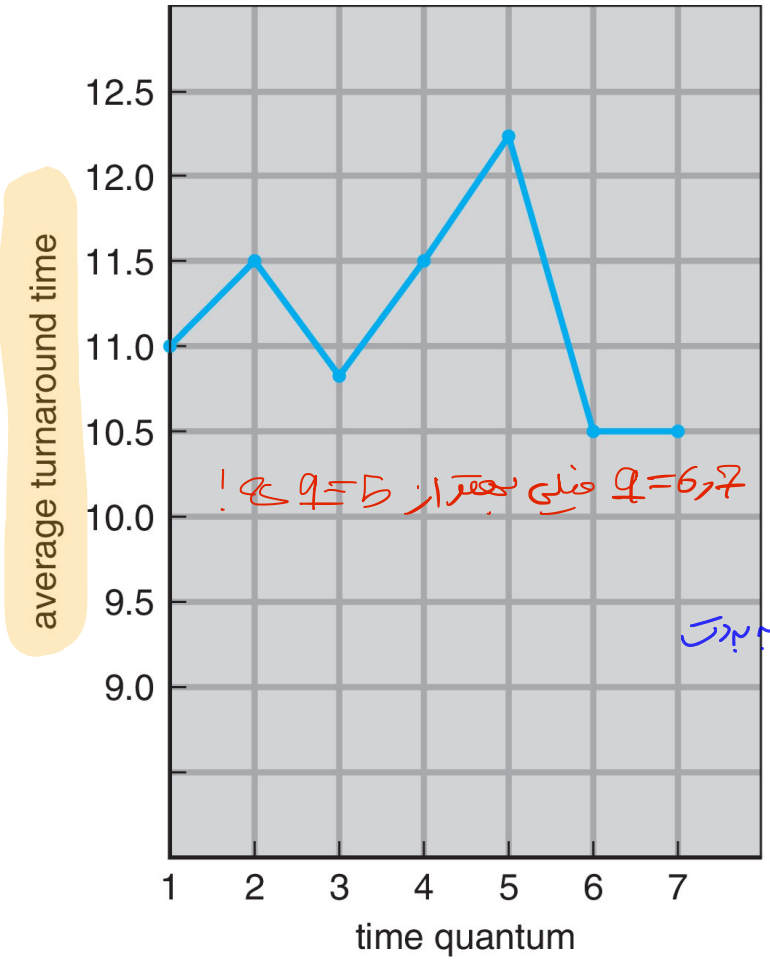
- Typically, higher average turnaround than SJF, but better ***response***
- *q* should be large compared to context switch time
  - **q** usually 10 milliseconds to 100 milliseconds,
  - Context switch < 10 microseconds

Time Quantum and Context Switch Time

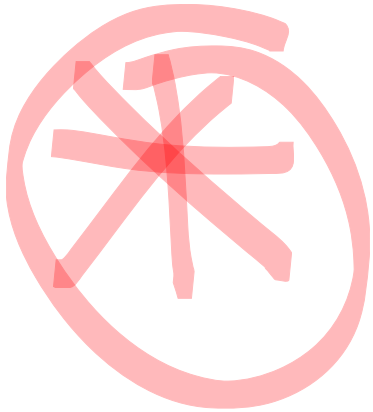


quantum	context switches
12	0
6	1
1	9

Turnaround Time Varies With The Time Quantum



process	time
P_1	6
P_2	3
P_3	1
P_4	7



A rule of thump is that

80% of CPU bursts should

be shorter than q

Priority Scheduling

- A priority number (integer) is associated with each process
- The CPU is allocated to the process with the highest priority

  (smallest integer ≡ highest priority)

  - Preemptive
  - Nonpreemptive

- SJF is priority scheduling where priority is the ***inverse of predicted next CPU burst time***

Priority Scheduling

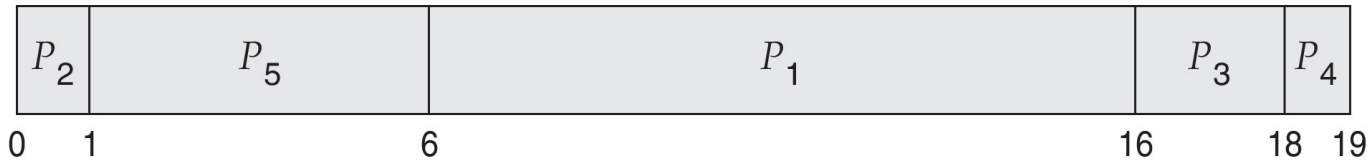
- **Problem ≡ Starvation**
  - Low priority processes may never execute
- **Solution ≡ Aging**
  - As time progresses increase the priority of the process

127 ← مثلاً اگر اولویت یک پردازه صفر باشد که صدا هر چند زمان می‌گذره از این عدد کم کن (اولویت آن را زیاد کنم!)

Example of Priority Scheduling

Process	Burst Time	Priority
P_1	10	3
P_2	1	1
P_3	2	4
P_4	1	5
P_5	5	2

- Priority scheduling Gantt Chart

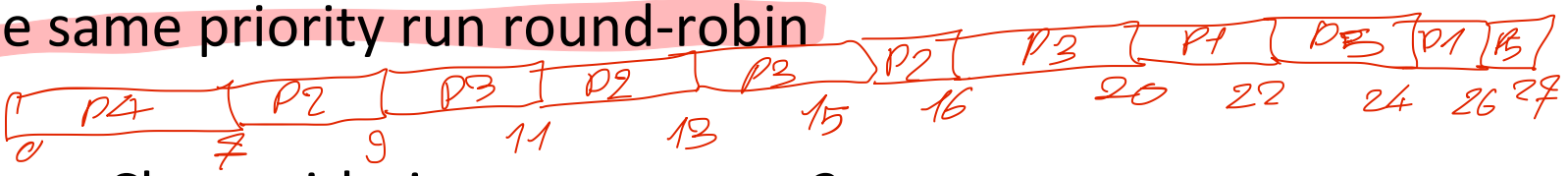


- Average waiting time = 8.2

Priority Scheduling w/ Round-Robin

Process	Burst Time	Priority
P_1	4	3
P_2	5	2
P_3	8	2
P_4	7	1
P_5	3	3

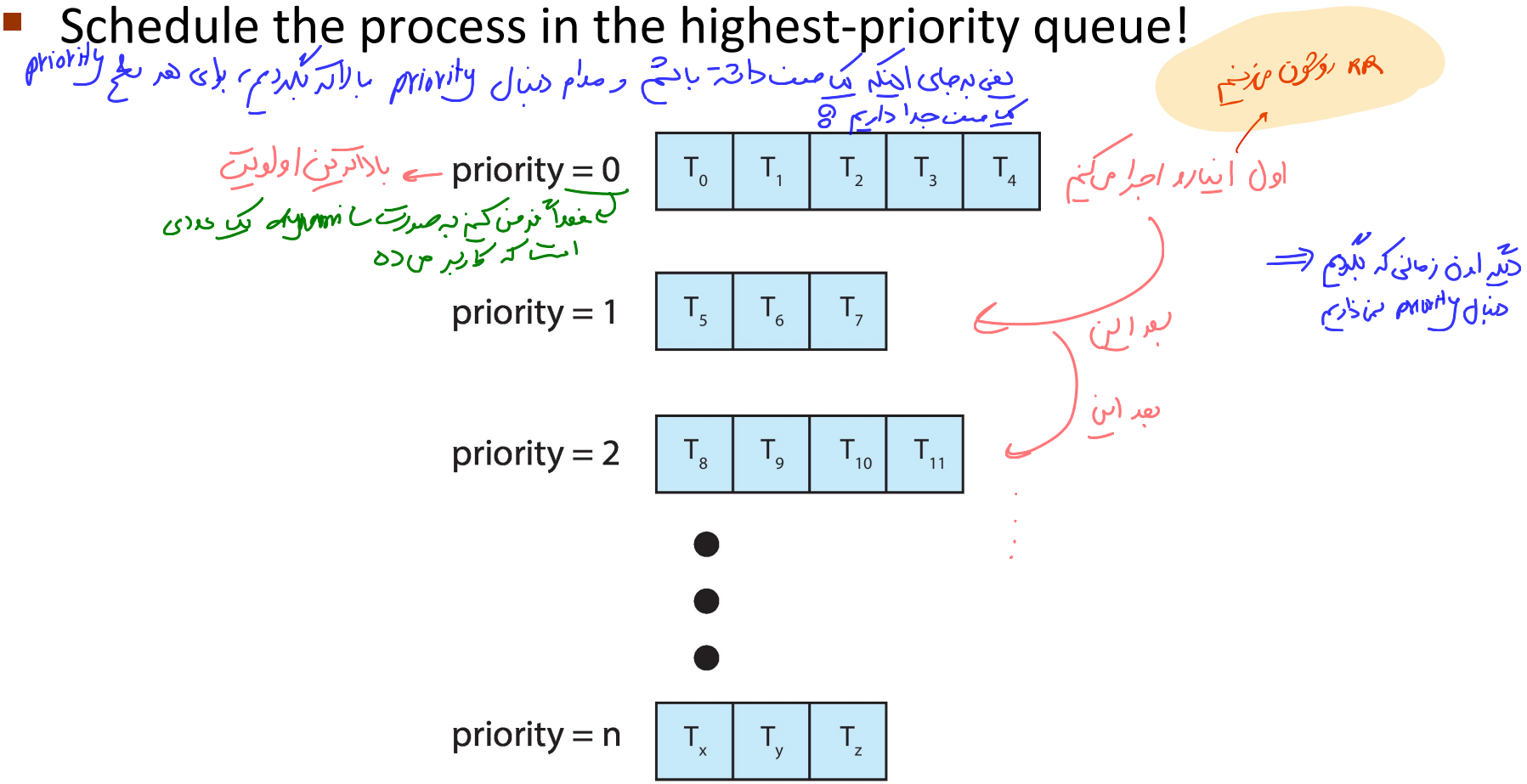
- Run the process with the highest priority. Processes with the same priority run round-robin



- Gantt Chart with time quantum = 2

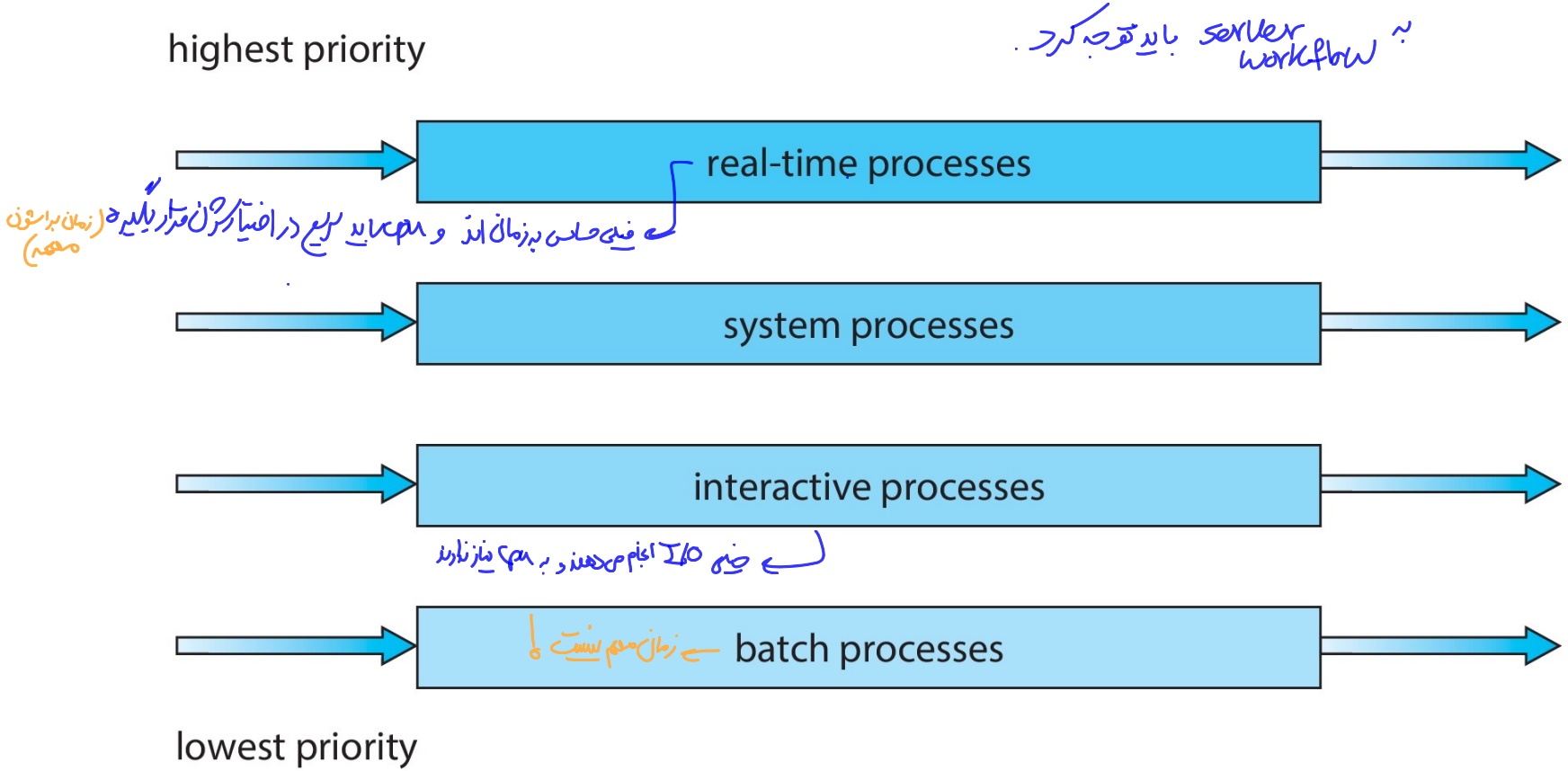
Multilevel Queue

- With priority scheduling, have separate queues for each priority.
- Schedule the process in the highest-priority queue!



Multilevel Queue

- Prioritization based upon process type

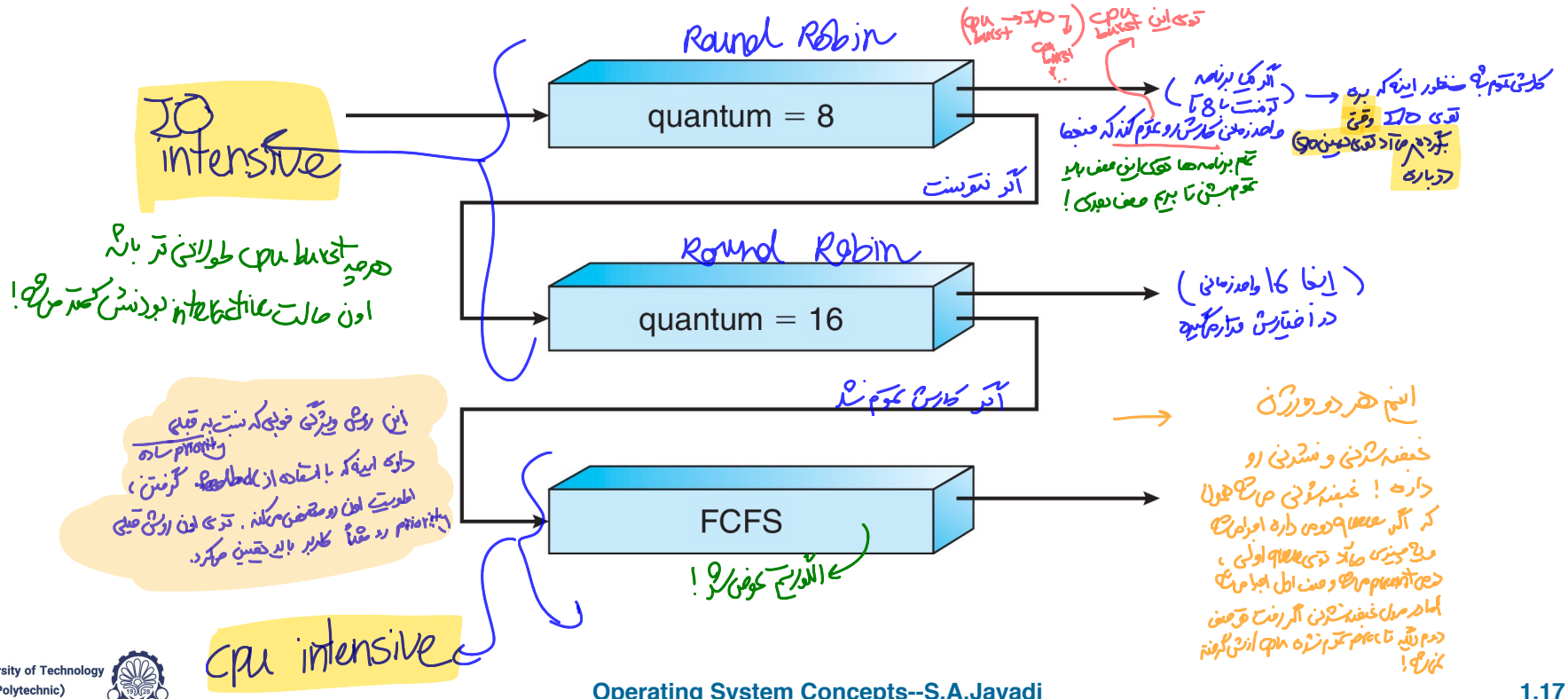


Multilevel Feedback Queue

- A process can move between the various queues.
- Multilevel-feedback-queue defined by the following parameters:
  - Number of queues
  - Scheduling algorithms for each queue
  - Method used to determine when to upgrade a process
  - Method used to determine when to demote a process
  - Method used to determine which queue a process will enter when that process needs service
- **Aging** can be implemented using multilevel feedback queue

Example of Multilevel Feedback Queue

- Three queues:
  - Q_0 – RR with time quantum 8 milliseconds
  - Q_1 – RR time quantum 16 milliseconds
  - Q_2 – FCFS



Example of Multilevel Feedback Queue (cont.)

- Scheduling
  - A new process enters queue Q_0 which is served in RR
    - When it gains CPU, the process receives 8 milliseconds
    - If it does not finish in 8 milliseconds, the process is moved to queue Q_1
  - At Q_1 job is again served in RR and receives 16 additional milliseconds
    - If it still does not complete, it is preempted and moved to queue Q_2