Faculty of Engineering and Technology

Electrical and Computer Engineering Department

OPERATING SYSTEMS

ENCS3390

Answers of assignment 2

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Problem

Consider the following set of processes:

Process	Arrival Time	Burst Time	Priority
P1	0	10	3
P2	1	8	2
P3	3	14	3
P4	4	7	1
P5	6	5	0
P6	7	4	1
P7	8	6	2

For each of the following scheduling algorithms, show the Gantt chart, average waiting time, and average turnaround time.

1- First Come First Served.

2- Shortest Job First.

3- Shortest Remaining Time First.

4- Round Robin, with q = 5

5- Priority Scheduling, with aging; where priority is decremented by 1 if the process remains in the ready queue for 5 time units.

Part One: First Come First Served Scheduling.

First, we need to build the **Gantt chart** according to the above table:

Gantt chart:

Now we need to calculate **The Turn Around time** and **The Waiting time** for each process:

- ⇨ To calculate **The Turn Around time,** we use the following formula:
  Turn Around time = Completion time – Arrival time

- ⇨ To calculate **The Waiting time,** we use the following formula:
  Waiting time = Turn Around time – Burst time

Process	Arrival Time	Burst Time	Completion Time	Turn Around Time	Waiting Time
P1	**0**	**10**	**10**	**10 - 0 = 10**	**10 – 10 = 0**
P2	**1**	**8**	**18**	**18 – 1 = 17**	**17 – 8 = 9**
P3	**3**	**14**	**32**	**32 – 3 = 29**	**29 – 14 = 15**
P4	**4**	**7**	**39**	**39 – 4 = 35**	**35 – 7 = 28**
P5	**6**	**5**	**44**	**44 – 6 = 38**	**38 – 5 = 33**
P6	**7**	**4**	**48**	**48 – 7 = 41**	**41 – 4 = 37**
P7	**8**	**6**	**54**	**54 – 8 = 46**	**46 – 6 = 40**

Now, calculate **Average Waiting time**, and **Average Turnaround time**:

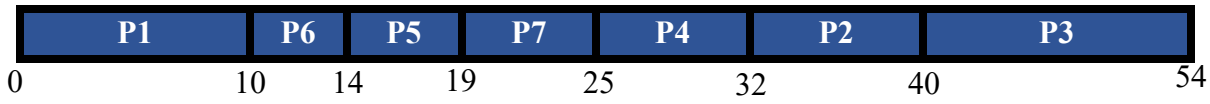
- ⇨ **Average Waiting time** = (0+9+15+28+33+37+40)/7 = 162/7 = **23.14 units**

- ⇨ **Average Turnaround time** = (10+17+29+35+38+41+46)/7 = 216/7 = **30.85 units**

Part Two: Shortest Job First Scheduling.

First, we need to build the **Gantt chart** according to the above table:

Gantt chart:



Now we need to calculate **The Turn Around time** and **The Waiting time** for each process:

- ⇨ To calculate **The Turn Around time,** we use the following formula:
  Turn Around time = Completion time – Arrival time

- ⇨ To calculate **The Waiting time,** we use the following formula:

  Waiting time = Turn Around time – Burst time

Process	Arrival Time	Burst Time	Completion Time	Turn Around Time	Waiting Time
P1	**0**	**10**	**10**	**10 - 0 = 10**	**10 – 10 = 0**
P2	**1**	**8**	**40**	**40 – 1 = 39**	**39 – 8 = 31**
P3	**3**	**14**	**54**	**54 – 3 = 51**	**51 – 14 = 37**
P4	**4**	**7**	**32**	**32 – 4 = 28**	**28 – 7 = 21**
P5	**6**	**5**	**19**	**19 – 6 = 13**	**13 – 5 = 8**
P6	**7**	**4**	**14**	**14 – 7 = 7**	**7 – 4 = 3**
P7	**8**	**6**	**25**	**25 – 8 = 17**	**17 – 6 = 11**

Now, calculate **Average Waiting time**, and **Average Turnaround time**:

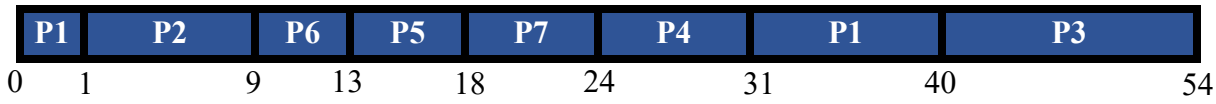
- ⇨ **Average Waiting time** = (0+31+37+21+8+3+11)/7 = 111/7 = **15.85 units**

- ⇨ **Average Turnaround time** = (10+39+51+28+13+7+17)/7 = 165/7 = **23.57 units**

Part Three: Shortest Remaining Time First Scheduling.

First, we need to build the **Gantt chart** according to the above table:

Gantt chart:



Now we need to calculate **The Turn Around time** and **The Waiting time** for each process:

- ⇨ To calculate **The Turn Around time,** we use the following formula:
  Turn Around time = Waiting time + Burst Time

- ⇨ To calculate **The Waiting time,** we use the following formula:

Waiting time = Total waiting time – No. of units process executed – Arrival time

Process	Arrival Time	Burst Time	Total waiting time	No. of units process executed	Waiting Time
P1	0	10	31	1	31 – 1 – 0 = 30
P2	1	8	1	0	1 – 0 – 1 = 0
P3	3	14	40	0	40 – 0 – 3 = 37
P4	4	7	24	0	24 – 0 – 4 = 20
P5	6	5	13	0	13 – 0 – 6 = 7
P6	7	4	9	0	9 – 0 – 7 = 2
P7	8	6	18	0	18 – 0 – 8 = 10

Process	Arrival Time	Burst Time	Waiting Time	Turn Around Time
P1	0	10	30	30 + 10 = 40
P2	1	8	0	0 + 8 = 8
P3	3	14	37	37 + 14 = 51
P4	4	7	20	20 + 7 = 27
P5	6	5	7	7 + 5 = 12
P6	7	4	2	2 + 4 = 6
P7	8	6	10	10 + 6 = 16

Now, calculate **Average Waiting time**, and **Average Turnaround time**:

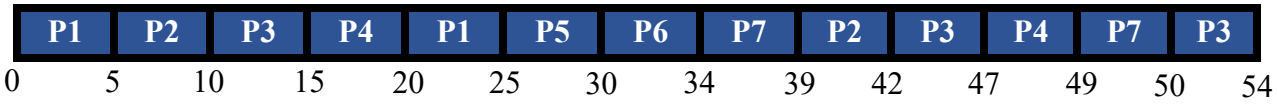
- **Average Waiting time** = (30+0+37+20+7+2+10)/7 = 106/7 = **15.14 units**
- **Average Turnaround time** = (40+8+51+24+13+9+18)/7 = 160/7 = **22.85 units**

Part Four: Round Robin Scheduling.

Note: q "Time Quantum" = 5 units.

First, we need to build the **Gantt chart** according to the above table:

Gantt chart:



Now we need to calculate **The Turn Around time** and **The Waiting time** for each process:

- ⇨ To calculate **The Turn Around time,** we use the following formula:
  Turn Around time = Waiting time + Burst Time

- ⇨ To calculate **The Waiting time,** we use the following formula:
  Waiting time = Total waiting time – No. of units process executed – Arrival time

Process	Arrival Time	Burst Time	Total waiting time	No. of units process executed	Waiting Time
P1	**0**	**10**	**20**	**5**	**20 – 5 – 0 = 15**
P2	**1**	**8**	**39**	**5**	**39 – 5 – 1 = 33**
P3	**3**	**14**	**50**	**10**	**50 – 10 – 3 = 37**
P4	**4**	**7**	**47**	**5**	**47 – 5 – 4 = 38**
P5	**6**	**5**	**25**	**0**	**25 – 0 – 6 = 19**
P6	**7**	**4**	**30**	**0**	**30 – 0 – 7 = 23**
P7	**8**	**6**	**49**	**5**	**49 – 5 – 8 = 36**

Process	Arrival Time	Burst Time	Waiting Time	Turn Around Time
P1	**0**	**10**	**15**	**15 + 10 = 25**
P2	**1**	**8**	**33**	**33 + 8 = 41**
P3	**3**	**14**	**37**	**37 + 14 = 51**
P4	**4**	**7**	**38**	**38 + 7 = 45**
P5	**6**	**5**	**19**	**19 + 5 = 24**
P6	**7**	**4**	**23**	**23 + 4 = 27**
P7	**8**	**6**	**36**	**36 + 6 = 42**

Now, calculate **Average Waiting time**, and **Average Turnaround time**:

- ⇨ **Average Waiting time** = (15+33+37+38+19+23+36)/7 = 201/7 = **28.71 units**
- ⇨ **Average Turnaround time** = (25+41+51+45+24+27+42)/7 = 255/7 = **36.42 units**

Part Five: Non-preemptive Priority Scheduling.

Note: priority is decremented by 1 if the process remains in the ready queue for 5 time units.

First, we need to build the **Gantt chart** according to the above table:

Gantt chart:

Now we need to calculate **The Turn Around time** and **The Waiting time** for each process:

- ⇨ To calculate **The Turn Around time,** we use the following formula:

  Turn Around time = Completion time – Arrival time

- ⇨ To calculate **The Waiting time,** we use the following formula:

  Waiting time = Turn Around time – Burst time

Process	Arrival Time	Burst Time	Priority	Completion Time	Turn Around Time	Waiting Time
P1	**0**	**10**	**3**	**10**	**10 – 0 = 10**	**10 – 10 = 0**
P2	**1**	**8**	**2**	**25**	**25 – 1 = 24**	**24 – 8 = 16**
P3	**3**	**14**	**3**	**39**	**39 – 3 = 36**	**36 – 14 = 22**
P4	**4**	**7**	**1**	**17**	**17 – 4 = 13**	**13 – 7 = 6**
P5	**6**	**5**	**0**	**44**	**44 – 6 = 38**	**38 – 5 = 33**
P6	**7**	**4**	**1**	**48**	**48 – 7 = 41**	**41 – 4 = 37**
P7	**8**	**6**	**2**	**54**	**54 – 8 = 46**	**46 – 6 = 40**

Now, calculate **Average Waiting time**, and **Average Turnaround time**:

- ⇨ **Average Waiting time** = (0+16+22+6+33+37+40)/7 = 154/7 = **22 units**
- ⇨ **Average Turnaround time** = (10+25+39+17+44+48+54)/7 = 208/7 = **29.71 units**