**Name: Zhu Jin Shun**

**ID:22101071d**

**COMP2432 A4**

**Question 1**

SRT

Gantt Chart

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| P1 | P2 | P3 | P2 | P5 | P1 | P4 |

0 1 2 3 7 14 22 31

Waiting time and turnaround time

|  |  |  |
| --- | --- | --- |
| Process | Waiting Time | Turnaround time |
| P1 | 13 | 22 |
| P2 | 1 | 6 |
| P3 | 0 | 1 |
| P4 | 18 | 27 |
| P5 | 2 | 9 |

Priority with preemption (Linux convention)

Gantt chart

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| P1 | P2 | P3 | P2 | P4 | P2 | P1 | P5 |

0 1 2 3 4 13 16 24 31

Waiting time and turnaround time

|  |  |  |
| --- | --- | --- |
| Process | Waiting Time | Turnaround time |
| P1 | 13 | 24 |
| P2 | 10 | 15 |
| P3 | 0 | 1 |
| P4 | 0 | 9 |
| P5 | 19 | 26 |

Priority with preemption (Windows convention)

Gantt chart

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| P1 | P5 | P1 | P2 | P4 | P3 |

0 5 12 16 21 30 31

Waiting time and turnaround time

|  |  |  |
| --- | --- | --- |
| Process | Waiting Time | Turnaround time |
| P1 | 7 | 16 |
| P2 | 15 | 20 |
| P3 | 28 | 29 |
| P4 | 17 | 26 |
| P5 | 0 | 7 |

**d)**

RR with quantum Q = 3

Gantt chart

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| P1 | P2 | P3 | P1 | P4 | P5 | P2 | P1 | P4 | P5 | P4 | P5 |

0 3 6 7 10 13 16 18 21 24 27 30 31

Waiting time and turnaround time

|  |  |  |
| --- | --- | --- |
| Process | Waiting Time | Turnaround time |
| P1 | 12 | 21 |
| P2 | 12 | 17 |
| P3 | 4 | 5 |
| P4 | 17 | 26 |
| P5 | 19 | 26 |

**e)**

RR with quantum Q = 2

Gantt chart

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| P1 | P2 | P1 | P3 | P2 | P4 | P5 | P1 | P2 |

0 2 4 6 7 9 11 13 15 16

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| P4 | P5 | P1 | P4 | P5 | P1 | P4 | P5 | P4 |

16 18 20 22 24 26 27 29 30 31

Waiting time and turnaround time

|  |  |  |
| --- | --- | --- |
| Process | Waiting Time | Turnaround time |
| P1 | 18 | 27 |
| P2 | 10 | 15 |
| P3 | 4 | 5 |
| P4 | 18 | 27 |
| P5 | 18 | 25 |

**f)**

Total weighted waiting time (w = 0.9)

= 1+ 0.9^1 + 0.9^2 + 0.9^3+0.9^4

= 4.0951

Total weighted waiting time (w = 0.8)

= 1+ 0.8^1 + 0.8^2 + 0.8^3+ 0.8^4

=3.3616

RR with quantum Q = 1

Gantt chart

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| P1 | P2 | P3 | P1 | P2 | P4 | P1 | P5 | P2 | P4 | P1 | P5 | P2 | P4 | P1 |

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| P5 | P2 | P4 | P1 | P5 | P4 | P1 | P5 | P4 | P1 | P5 | P4 | P1 | P5 | P4 |

15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 31

**Resulting weighted waiting time (w = 0.9):**

SRT Scheduling

|  |  |
| --- | --- |
| Process | Waiting Time |
| P1 | 11.7 |
| P2 | 0.9 |
| P3 | 0 |
| P4 | 18 |
| P5 | 2 |

Linux convention

|  |  |
| --- | --- |
| Process | Waiting Time |
| P1 | 13.5 |
| P2 | 8.2 |
| P3 | 0 |
| P4 | 0 |
| P5 | 19 |

Window convention

|  |  |
| --- | --- |
| Process | Waiting Time |
| P1 | 6.3 |
| P2 | 15 |
| P3 | 28 |
| P4 | 17 |
| P5 | 0 |

Round Robin(quantum=3)

|  |  |
| --- | --- |
| Process | Waiting Time |
| P1 | 10.1 |
| P2 | 11 |
| P3 | 4 |
| P4 | 15.6 |
| P5 | 17.6 |

Round Robin(quantum=2)

|  |  |
| --- | --- |
| Process | Waiting Time |
| P1 | 13.7 |
| P2 | 8.6 |
| P3 | 4 |
| P4 | 15.6 |
| P5 | 15.9 |

Round Robin(quantum=1)

|  |  |
| --- | --- |
| Process | Waiting Time |
| P1 | 10.5 |
| P2 | 9.4 |
| P3 | 2 |
| P4 | 14.4 |
| P5 | 12.8 |

**Resulting weighted waiting time (w = 0.8) :**

SRT Scheduling

|  |  |
| --- | --- |
| Process | Waiting Time |
| P1 | 10.4 |
| P2 | 0.8 |
| P3 | 0 |
| P4 | 18 |
| P5 | 2 |

Linux convention

|  |  |
| --- | --- |
| Process | Waiting Time |
| P1 | 12 |
| P2 | 6.6 |
| P3 | 0 |
| P4 | 0 |
| P5 | 19 |

Window convention

|  |  |
| --- | --- |
| Process | Waiting Time |
| P1 | 5.6 |
| P2 | 15 |
| P3 | 28 |
| P4 | 17 |
| P5 | 0 |

Round Robin(quantum=3)

|  |  |
| --- | --- |
| Process | Waiting Time |
| P1 | 8.3 |
| P2 | 10 |
| P3 | 4 |
| P4 | 14.3 |
| P5 | 15.3 |

Round Robin(quantum=2)

|  |  |
| --- | --- |
| Process | Waiting Time |
| P1 | 10.3 |
| P2 | 7.2 |
| P3 | 4 |
| P4 | 13.5 |
| P5 | 14.1 |

Round Robin(quantum=1)

|  |  |
| --- | --- |
| Process | Waiting Time |
| P1 | 5.8 |
| P2 | 7.3 |
| P3 | 2 |
| P4 | 11.1 |
| P5 | 10.3 |

**Question 2**

**a)**

Gantt chart

High priority queue

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| P1 | P2 | P1 | P3 | P2 | P4 | P5 | P3 | P4 | P5 |

0 2 4 6 8 10 12 14 16 18 20

Medium priority queue

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| P1 | P2 | P3 | P4 | P5 |

20 23 26 29 30 33

Low priority queue

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| P1 | P3 | P5 | P1 | P3 | P5 |

33 36 39 42 47 48 50

Waiting time and turnaround time

|  |  |  |
| --- | --- | --- |
| Process | Waiting Time | Turnaround time |
| P1 | 32 | 47 |
| P2 | 18 | 25 |
| P3 | 35 | 46 |
| P4 | 21 | 26 |
| P5 | 32 | 44 |

**b)**

High priority queue=50/10\*5=25 time units

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| P1 | P2 | P1 | P3 | P2 | P1 | P2 | P4 | P5 | P3 | P4 | P5 |

0 2 4 6 8 10 13 16 18 20 22 24 25

Medium priority queue=50/10\*3=15 time units

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| P5 | P1 | P3 | P1 | P4 | P5 |

25 26 29 32 36 37 40

Low priority queue==50/10\*2=10 time units

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| P5 | P1 | P5 | P3 | P5 | P3 |

40 42 43 46 47 49 50

Waiting time and turnaround time

|  |  |  |
| --- | --- | --- |
| Process | Waiting Time | Turnaround time |
| P1 | 34 | 43 |
| P2 | 10 | 15 |
| P3 | 47 | 48 |
| P4 | 24 | 33 |
| P5 | 37 | 44 |

**Question 3**

**a)**

First-Fit

210K 291K 254K

|  |  |  |
| --- | --- | --- |
| 84K+90K+20K | 97K+81K+79K+22K | 77K+64K+56K+38K |

68KB no positions- waiting

Utilization:

Hole 1: Utilized 194K out of 210K (16K remaining)

Hole 2: Utilized 279K out of 291K (11K remaining)

Hole 3: Utilized 235K out of 254K (19K remaining)

Leftover space

=(210-20-84-90)+(291-97-81-79-22)+(254-77-64-56-38)

=47K

**b)**

Best-Fit

210K 291K 254K

|  |  |  |
| --- | --- | --- |
| 84K+90KB+20KB | 79K+77K+68K+56K | 97K+81K+64K |

38K and 22K no position- waiting

Utilization:

Hole 1: Utilized 194K out of 210K (16K remaining)

Hole 2: Utilized 280K out of 291K (11K remaining)

Hole 3: Utilized 242K out of 254K (12K remaining)

Leftover space

=(210-20-84-90)+(291-79-77-68-56)+(254-97-81-64)

=39K

**c)**

Worst-Fit

210K 291K 254K

|  |  |  |
| --- | --- | --- |
| 97K+77K+ | 84K+81K+20K+64K+22K | 90K+79K+56K+ |

68, 38KB no positions- waiting

Utilization:

Hole 1: Utilized 174K out of 210K (36K remaining)

Hole 2: Utilized 271K out of 291K (20K remaining)

Hole 3: Utilized 225K out of 254K (29K remaining)

Leftover space

=(210-77-97)+(291-84-81-64-20-22)+(254-79-90-56)

=85K

**d)**

Optimal 1

210K 291K 254K

|  |  |  |
| --- | --- | --- |
| 56K+64K+81K | 84K+90K+97K+20K | 79K+77K+68K+22K |

38K no position waiting

Utilization:

Hole 1: Utilized 201K out of 210K (9K remaining)

Hole 2: Utilized 291K out of 291K (0K remaining)

Hole 3: Utilized 246K out of 254K (8K remaining)

Leftover space

=(210-56-64-81)+(291-90-84-97-20)+(254-77-79-68-22)

=17K

Optimal 2

210K 291K 254K

|  |  |  |
| --- | --- | --- |
| 56K+64K+68K+22K | 84K+90K+97K+20K | 79K+77K+81K |

38K no position waiting

Utilization:

Hole 1: Utilized 210K out of 210K (0K remaining)

Hole 2: Utilized 291K out of 291K (0K remaining)

Hole 3: Utilized 237K out of 254K (17K remaining)

Leftover space

=(210-56-64-68-22)+(291-90-84-97-20)+(254-77-79-81)

=17K

**e)**

Yes, an improvement can be made when (iii) 210K, 291K, 255K is used, we can have 100% utilization with 0K leftover space, here is the fitting:

210K 291K 255K

|  |  |  |
| --- | --- | --- |
| 56K+64K+68K+22K | 77K+79K+97K+38K | 90K+84K+81K |

20K no position waiting

Utilization:

Hole 1: Utilized 210K out of 210K (0K remaining)

Hole 2: Utilized 291K out of 291K (0K remaining)

Hole 3: Utilized 255K out of 255K (0K remaining)

Leftover space

=(210-56-64-68-22)+(291-77-79-97-38)+(255-90-84-81)

=0K

100% utilization

**f)**

**S=800:**

x = 0

y = 8

z = 7

Total value for this combination:

36 \* 0 + 48 \* 8+ 59 \* 7

= 384+413

= 797

Unused space

=800-797

=3K

**S=775:**

x = 9

y = 4

z = 5

Total value for this combination:

26 \* 9 + 57 \* 4 + 62 \* 5

= 234 + 228 + 310

= 772

Unused space

=775-772

=3K

**S=570:**

x = 0

y = 7

z = 6

Total value for this combination:

29 \* 0 + 39 \* 7 + 49 \* 6

=273 + 294

=567

Unused space

=570-567

=3K

**g)**

**S=800:**

x = 0

y = 8

z = 7

Total value for this combination:

36 \* 0 + 48 \* 8+ 59 \* 7

= 384+413

= 797

Unused space

=800-797

=3K

**S=775:**

x = 23

y = 2

z = 5

Total value for this combination:

26 \* 23 + 57 \* 2 + 62 \* 1

= 598+ 114 + 62

= 774

Unused space

=775-774

=1K

**S=570:**

x = 1

y = 0

z = 11

Total value for this combination:

29 \* 1 + 39 \* 0 + 49 \* 11

=29 + 539

=568

Unused space

=570-568

=2K

**h)**

**S=800:**

x = 8

y = 8

z = 2

Total value for this combination:

36 \* 8 + 48 \* 8+ 59 \* 2

= 288+ 384+108

= 790

Unused space

=800-790

=10K

**S=775:**

x = 9

y = 4

z = 5

Total value for this combination:

26 \* 9 + 57 \* 4 + 62 \* 5

= 234 + 228 + 310

= 772

Unused space

=775-772

=3K

**S=570:**

x = 9

y = 4

z = 3

Total value for this combination:

29 \* 9 + 39 \* 4 + 49 \* 3

=261 + 156 + 147

=564

Unused space

=570-564

=6K

**Question 4**

**a)**

First-Fit

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| 999 |  | 345 | 55+103+212+72 | 234 |  | 304 |

0 999 1011 1356 1901 2135 2432 2736

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 999 | 135 | 604 | 135 | 352 | 787 |

2736 3011 3146 3901 4036 4434 5215

|  |  |  |
| --- | --- | --- |
| 304 | 543 |  |

5215 5679 6221 6789

P2

|  |  |  |
| --- | --- | --- |
| Segment | Base | Length/Limit |
| 0 | 1356 | 55 |
| 1 | 3146 | 604 |
| 2 | 1411 | 103 |
| 3 | 1514 | 212 |
| 4 | 1726 | 72 |
| 5 | 4036 | 352 |
| 6 | 5215 | 304 |

**b)**

Best-Fit

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| 999 |  | 345 |  | 234 | 212+72 | 304 |

0 999 1011 1356 1901 2135 2432 2736

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 55+103 | 135 | 604 | 135 | 352 | 787 |

2736 3011 3146 3901 4036 4434 5215

|  |  |  |
| --- | --- | --- |
| 304 | 543 |  |

5215 5679 6221 6789

P2

|  |  |  |
| --- | --- | --- |
| Segment | Base | Length/Limit |
| 0 | 2736 | 55 |
| 1 | 3146 | 604 |
| 2 | 2791 | 103 |
| 3 | 2135 | 212 |
| 4 | 2347 | 72 |
| 5 | 4036 | 352 |
| 6 | 5215 | 304 |

**c)**

Worst-Fit

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| 999 |  | 345 | 212 | 234 |  | 304 |

0 999 1011 1356 1901 2135 2432 2736

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 999 | 135 | 55+604 | 135 |  | 787 |

2736 3011 3146 3901 4036 4434 5215

|  |  |  |
| --- | --- | --- |
| 352 | 543 | 103+72+304 |

5215 5679 6221 6789

P2

|  |  |  |
| --- | --- | --- |
| Segment | Base | Length/Limit |
| 0 | 3146 | 55 |
| 1 | 3201 | 604 |
| 2 | 6221 | 103 |
| 3 | 1356 | 212 |
| 4 | 6324 | 72 |
| 5 | 5215 | 352 |
| 6 | 6396 | 304 |

**d)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Allocation algorithm for P2 | | FF | BF | WF |
| Logical address | Physical address for P1 | Physical address for P2 | | |
| (0, 44) | 3055 | 1400 | 2780 | 3190 |
| (1, 231) | 2132 | 3377 | 3377 | 3432 |
| (2, 82) | 5760 | 1493 | 2873 | 6303 |
| (3, 199) | 2631 | 1713 | 2334 | 1555 |
| (4, 56) | 4490 | 1782 | 2403 | 6380 |
| (5, 304) | 1315 | 4340 | 4340 | 5519 |
| (6, 135) | 4036 | 5350 | 5350 | 6531 |