**Solution Chapter 15 exercises**

**(15.7,15.11,15.13,15.17,15.19)**

**15.7** Original problem:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Squad\Case | A | B | C | D | E |
| 1 | 14 | 7 | 3 | 7 | 27 |
| 2 | 20 | 7 | 12 | 6 | 30 |
| 3 | 10 | 3 | 4 | 5 | 21 |
| 4 | 8 | 12 | 7 | 12 | 21 |
| 5 | 13 | 25 | 24 | 26 | 8 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| (a) Row subtraction is done next: | | | | | |
| Squad\Case | A | B | C | D | E |
| 1 | 11 | 4 | 0 | 4 | 24 |
| 2 | 14 | 1 | 6 | 0 | 24 |
| 3 | 7 | 0 | 1 | 2 | 18 |
| 4 | 1 | 5 | 0 | 5 | 14 |
| 5 | 5 | 17 | 16 | 18 | 0 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Column subtraction is done next: | | | | | |
| Squad\Case | A | B | C | D | E |
| 1 | 10 | 4 | 0 | 4 | 24 |
| 2 | 13 | 1 | 6 | 0 | 24 |
| 3 | 6 | 0 | 1 | 2 | 18 |
| 4 | 0 | 5 | 0 | 5 | 14 |
| 5 | 4 | 17 | 16 | 18 | 0 |

Cover zeros with lines:

FG15_07a_0131585576

Optimal assignment:

Squad 1 to case *C*

Squad 2 to case *D*

Squad 3 to case *B*

Squad 4 to case *A*

Squad 5 to case *E*

Total person-days projected using this assignment 3 6   
3 8 8 28 days.

(b) We can avoid the assignment of squad 5 to case E occurring by assigning a very high value to that combination. In this case, we assign 50.

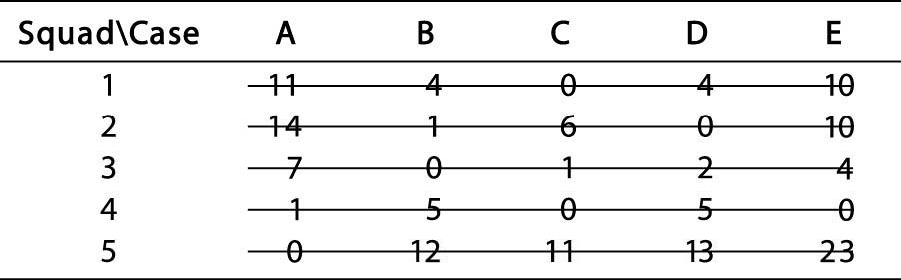
Problem:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Squad\Case | A | B | C | D | E |
| 1 | 14 | 7 | 3 | 7 | 27 |
| 2 | 20 | 7 | 12 | 6 | 30 |
| 3 | 10 | 3 | 4 | 5 | 21 |
| 4 | 8 | 12 | 7 | 12 | 21 |
| 5 | 13 | 25 | 24 | 26 | 50 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Row subtraction is done next: | | | | | |
| Squad\Case | A | B | C | D | E |
| 1 | 11 | 4 | 0 | 4 | 24 |
| 2 | 14 | 1 | 6 | 0 | 24 |
| 3 | 7 | 0 | 1 | 2 | 18 |
| 4 | 1 | 5 | 0 | 5 | 14 |
| 5 | 0 | 12 | 11 | 13 | 37 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Column subtraction is done next: | | | | | |
| Squad\Case | A | B | C | D | E |
| 1 | 11 | 4 | 0 | 4 | 10 |
| 2 | 14 | 1 | 6 | 0 | 10 |
| 3 | 7 | 0 | 1 | 2 | 4 |
| 4 | 1 | 5 | 0 | 5 | 0 |
| 5 | 0 | 12 | 11 | 13 | 23 |

Cover zeros with lines:



Optimal assignment:

Squad 1 to case *C*

Squad 2 to case *D*

Squad 3 to case *B*

Squad 4 to case *E*

Squad 5 to case *A*

Total person-days projected using this assignment 3 6 3 21 13 46.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **15.11** | Job | Due Date | Remaining Days | Critical Ratio |
|  | 103 | 214 | 10 | 1.40 |
|  | 205 | 223 | 7 | 3.29 |
|  | 309 | 217 | 11 | 1.55 |
|  | 412 | 219 | 5 | 3.80 |
|  | 517 | 217 | 15 | 1.13 |

Jobs should be scheduled in the sequence 517, 103, 309, 205, 412 if scheduled by the critical ratio scheduling rule.

**15.13** (a)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Dispatching Rule | Job Sequence | Flow Time | Utilization | Average Number of Jobs | Average Late |
| EDD | CX–BR–SY–DE–RG | 385 | 37.6% | 2.66 | 10 |
| SPT | BR–CX–SY–DE–RG | 375 | 38.6% | 2.59 | 12 |
| LPT | RG–DE–SY–CX–BR | 495 | 29.3% | 3.41 | 44 |
| FCFS | CX–BR–DE–SY–RG | 390 | 37.2% | 2.69 | 12 |

Starting day number: 241 (i.e., work can be done on day 241)

**Method: SPT—Shortest processing time**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Processing Time | | | Due Date | Order | Flow Time | | | Completion Time | Late | | |
| CX-01 | 25 | | | 270 | 2 | 40 | | | 280 | 10 | | |
| BR-02 | 15 | | | 300 | 1 | 15 | | | 255 | 0 | | |
| DE-06 | 35 | | | 320 | 4 | 105 | | | 345 | 25 | | |
| SY-11 | 30 | | | 310 | 3 | 70 | | | 310 | 0 | | |
| RG-05 |  | 40 |  | 360 | 5 |  | 145 |  | 385 |  | 25 |  |
| Total | 145 | | |  |  | 375 | | |  | 60 | | |
| Average |  | | |  |  | 75 | | |  | 12 | | |
| Sequence: BR-02,CX-01,SY-11,DE-06,RG-05 Average # in system =2.586 =375/145 | | | | | | | | | | | | |

(b) The best flowtime is SPT;

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Method: LPT—Longest processing time | | | | | | | | | | | | | | | | | | | | | | |
|  | Processing Time | | | | | | Due Date | | Order | | Flow Time | | | | Completion Time | | | | Late | | | |
| CX-01 | 25 | | | | | | 270 | | 4 | | 130 | | | | 370 | | | | 100 | | | |
| BR-02 | 15 | | | | | | 300 | | 5 | | 145 | | | | 385 | | | | 85 | | | |
| DE-06 | 35 | | | | | | 320 | | 2 | | 75 | | | | 315 | | | | 0 | | | |
| SY-11 | 30 | | | | | | 310 | | 3 | | 105 | | | | 345 | | | | 35 | | | |
| RG-05 |  | | 40 |  | | | 360 | | 1 | |  | 40 |  | | 280 | | | |  | | 0 |  |
| Total | 145 | | | | | |  | |  | | 495 | | | |  | | | | 220 | | | |
| Average |  | | | | | |  | |  | | 99 | | | |  | | | | 44 | | | |
| Sequence: RG-05,DE-06,SY-11,CX-01,BR-02, Average # in system =3.414 =495/145 | | | | | | | | | | | | | | | | | | | | | | |
| Method: Earliest due date (EDD); earliest to latest date | | | | | | | | | | | | | | | | | | | | | | | | | | |
|  | | Processing Time | | | | | | Due Date | | Slack | | | | Order | | Flow Time | | | | Completion Time | | | | Late | | |
| CX-01 | | 25 | | | | | | 270 | | 0 | | | | 1 | | 25 | | | | 265 | | | | 0 | | |
| BR-02 | | 15 | | | | | | 300 | | 0 | | | | 2 | | 40 | | | | 280 | | | | 0 | | |
| DE-06 | | 35 | | | | | | 320 | | 0 | | | | 4 | | 105 | | | | 345 | | | | 25 | | |
| SY-11 | | 30 | | | | | | 310 | | 0 | | | | 3 | | 70 | | | | 310 | | | | 0 | | |
| RG-05 | |  | | | 40 |  | | 360 | | 0 | | | | 5 | |  | 145 |  | | 385 | | | |  | 25 |  |
| Total | | 145 | | | | | |  | |  | | | |  | | 385 | | | |  | | | | 50 | | |
| Average | |  | | | | | |  | |  | | | |  | | 77 | | | |  | | | | 10 | | |
| Sequence: CX-01,BR-02,SY-11,DE-06,RG-05 Average # in system =2.655 =385/145 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Method: First come, first served (FCFS) | | | | | | | | | | | | | | | | | | | | | | | | | | |
|  | | Processing Time | | | | | | Due Date | | Slack | | | | Order | | Flow Time | | | | Completion Time | | | | Late | | |
| CX-01 | | 25 | | | | | | 270 | | 0 | | | | 1 | | 25 | | | | 265 | | | | 0 | | |
| BR-02 | | 15 | | | | | | 300 | | 0 | | | | 2 | | 40 | | | | 280 | | | | 0 | | |
| DE-06 | | 35 | | | | | | 320 | | 0 | | | | 3 | | 75 | | | | 315 | | | | 0 | | |
| SY-11 | | 30 | | | | | | 310 | | 0 | | | | 4 | | 105 | | | | 345 | | | | 35 | | |
| RG-05 | |  | | | 40 |  | | 360 | | 0 | | | | 5 | |  | 145 |  | | 385 | | | |  | 25 |  |
| Total | | 145 | | | | | |  | |  | | | |  | | 390 | | | |  | | | | 60 | | |
| Average | |  | | | | | |  | |  | | | |  | | 78 | | | |  | | | | 12 | | |
| Sequence: CX-01,BR-02,DE-06,SY-11,RG-05, Average # in system =2.69 =390/145 | | | | | | | | | | | | | | | | | | | | | | | | | | |

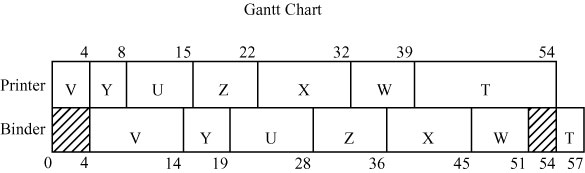
(c) best utilization is SPT;

(d) best lateness is EDD.

(e) Students could support  
either of these choices. LPT scores poorly on all three  
criteria.

**15.17**(a, c) The jobs should be processed in the sequence   
 V–Y–U–Z–X–W–T, for a total time of 57.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | Job Shop Scheduling Flow Time | | | | | | |
|  | Printer | Binder | Order | Printer | Binder | | |
| T | 15 | 3 | seventh | 54 | 57 | | |
| U | 7 | 9 | third | 15 | 28 | | |
| V | 4 | 10 | first | 4 | 14 | | |
| W | 7 | 6 | sixth | 39 | 51 | | |
| X | 10 | 9 | fifth | 32 | 45 | | |
| Y | 4 | 5 | second | 8 | 19 | | |
| Z | 7 | 8 | fourth | 22 |  | 36 |  |
| Time |  |  |  |  | 57 | | |

(b, c)

Note: Y could also be placed first, with no change in total times.

(d) Binding is idle from 0 to 4 and from 51 to 54 for a total of 7 hours.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **15.19** |  | Monday | Tuesday | Wednesday | Thursday | Friday | Saturday | Sunday |
|  | Worker 1 | 6 | 5 | 5 | 5 | 6 | 4 | 3 |
|  | Worker 2 | 5 | 4 | 4 | 4 | 5 | 4 | 3 |
|  | Worker 3 | 4 | 3 | 3 | 3 | 4 | 4 | 3 |
|  | Worker 4 | 3 | 3 | 3 | 2 | 3 | 3 | 2 |
|  | Worker 5 | 2 | 2 | 2 | 1 | 2 | 3 | 2 |
|  | Worker 6 | 1 | 1 | 2 | 1 | 1 | 2 | 1 |
|  | Worker 7 | 1 | 1 | 1 | 0 | 0 | 1 | 0 |

Note: Seven employees are needed; six have two consecutive   
days off. The 7th worker has two consecutive days off but   
only works 4 days. Days off are circled.