PROBLEMS

1. Use the assignment method to determine the best way to assign workers to jobs, given the following cost information. Compute the total cost for your assignment plan.

		JOB		
		A	B	C
Worker	1	5	8	6
	2	6	7	9
	3	4	5	3

2. Rework Problem 1, treating the numbers in the table as profits instead of costs. Compute the total profit.
3. Assign trucks to delivery routes so that total costs are minimized, given the cost data shown. What is the total cost?

		ROUTE				
		A	B	C	D	E
Truck	1	4	5	9	8	7
	2	6	4	8	3	5
	3	7	3	10	4	6
	4	5	2	5	5	8
	5	6	5	3	4	9

4. Develop an assignment plan that will minimize processing costs, given the information shown, and interpret your answer.

		WORKER		
		A	B	C
Job	1	12	8	11
	2	13	10	8
	3	14	9	14
	4	10	7	12

5. Use the assignment method to obtain a plan that will minimize the processing costs in the following table under these conditions:
   a. The combination 2-D is undesirable
   b. The combinations 1-A and 2-D are undesirable

		WORKER				
		A	B	C	D	E
Job	1	14	18	20	17	18
	2	14	15	19	16	17
	3	12	16	15	14	17
	4	11	13	14	12	14
	5	10	16	15	14	13

6. The following table contains information concerning four jobs that are awaiting processing at a work center.

Job	Job Time (days)	Due Date (days)
A	14	20
B	10	16
C	7	15
D	6	17

a. Sequence the jobs using (1) FCFS, (2) SPT, (3) EDD, and (4) CR. Assume the list is by order of arrival.

b. For each of the methods in part *a*, determine (1) the average job flow time, (2) the average tardiness, and (3) the average number of jobs at the work center.

c. Is one method superior to the others? Explain.

7. Using the information presented in the following table, identify the processing sequence that would result using (1) FCFS, (2) SPT, (3) EDD, and (4) CR. For each method, determine (1) average job flow time, (2) average job tardiness, and (3) average number of jobs in the system. Jobs are listed in order of arrival. (*Hint:* First determine the total job time for each job by computing the total processing time for the job and then adding in the setup time. All times and due dates are in hours.)

Job	Processing Time per Unit	Units per Job	Setup Time	Due Date
a	.14	45	0.7	4
b	.25	14	0.5	10
c	.10	18	0.2	12
d	.25	40	1.0	20
e	.10	75	0.5	15

8. The following table shows orders to be processed at a machine shop as of 8:00 a.m. Monday. The jobs have different operations they must go through. Processing times are in days. Jobs are listed in order of arrival.

a. Determine the processing sequence at the first work center using each of these rules: (1) FCFS, (2) S/O.

b. Compute the effectiveness of each rule using each of these measures: (1) average flow time, (2) average number of jobs at the work center.

Job	Processing Time (days)	Due Date (days)	Remaining Number of Operations
A	8	20	2
B	10	18	4
C	5	25	5
D	11	17	3
E	9	35	4

9. A wholesale grocery distribution center uses a two-step process to fill orders. Tomorrow's work will consist of filling the seven orders shown. Determine a job sequence that will minimize the time required to fill the orders.

	TIME (hours)	
Order	Step 1	Step 2
A	1.20	1.40
B	0.90	1.30
C	2.00	0.80
D	1.70	1.50
E	1.60	1.80
F	2.20	1.75
G	1.30	1.40

10. The times required to complete each of eight jobs in a two-machine flow shop are shown in the table that follows. Each job must follow the same sequence, beginning with machine A and moving to machine B.

a. Determine a sequence that will minimize makespan time.

b. Construct a chart of the resulting sequence, and find machine B's idle time.

c. For the sequence determined in part *a*, how much would machine B's idle time be reduced by splitting the last two jobs in half?

	TIME (hours)	
Job	Machine A	Machine B
a	16	5
b	3	13
c	9	6
d	8	7
e	2	14
f	12	4
g	18	14
h	20	11

11. Given the operation times provided:
    a. Develop a job sequence that minimizes idle time at the two work centers.
    b. Construct a chart of the activities at the two centers, and determine each one's idle time, assuming no other activities are involved.

	JOB TIMES (minutes)					
	A	B	C	D	E	F
Center 1	20	16	43	60	35	42
Center 2	27	30	51	12	28	24

12. A shoe repair operation uses a two-step sequence that all jobs in a certain category follow. All jobs can be split in half at both stations. For the group of jobs listed:
    a. Find the sequence that will minimize total completion time.
    b. Determine the amount of idle time for workstation B.
    c. What jobs are candidates for splitting? Why? If they were split, how much would idle time and makespan time be reduced?

	JOB TIMES (minutes)				
	A	B	C	D	E
Workstation A	27	18	70	26	15
Workstation B	45	33	30	24	10

13. The following schedule was prepared by the production manager of Marymount Metal Shop: Determine a schedule that will result in the earliest completion of all jobs on this list.

	CUTTING		POLISHING	
Job	Start	Finish	Start	Finish
A	0	2	2	5
B	2	6	6	9
C	6	11	11	13
D	11	15	15	20
E	15	17	20	23
F	17	20	23	24
G	20	21	24	28

14. The production manager must determine the processing sequence for seven jobs through the grinding and then deburring departments. The same sequence will be followed in both departments. The manager's goal is to move the jobs through the two departments as quickly as possible. The foreman of the deburring department wants the SPT rule to be used to minimize the work-in-process inventory in his department.

Job	PROCESSING TIME (hours) Grinding	Deburring
A	3	6
B	2	4
C	1	5
D	4	3
E	9	4
F	8	7
G	6	2

a. Prepare a schedule using SPT for the grinding department.

b. What is the flow time in the grinding department for the SPT sequence? What is the total time needed to process the seven jobs in both the grinding and deburring departments?

c. Determine a sequence that will minimize the total time needed to process the jobs in both departments. What flow time will result for the grinding department?

d. Discuss the trade-offs between the two alternative sequencing arrangements. At what point would the production manager be indifferent concerning the choice of sequences?

15. A foreman has determined processing times at a work center for a set of jobs and now wants to sequence them. Given the information shown, do the following:

a. Determine the processing sequence using (1) FCFS, (2) SPT, (3) EDD, and (4) CR. For each sequence, compute the average job tardiness, the average flow time, and the average number of jobs at the work center. The list is in FCFS order.

b. Using the results of your calculations in part *a,* show that the ratio of average flow time and the average number of jobs measures are equivalent for all four sequencing rules.

c. Determine the processing sequence that would result using the S/O rule.

Job	Job Time (days)	Due Date	Operations Remaining
a	4.5	10	3
b	6.0	17	4
c	5.2	12	3
d	1.6	27	5
e	2.8	18	3
f	3.3	19	1

16. Given the information in the following table, determine the processing sequence that would result using the S/O rule.

Job	Remaining Processing Time (days)	Due Date	Remaining Number of Operations
a	5	8	2
b	6	5	4
c	9	10	4
d	7	12	3
e	8	10	2

17. Given the following information on job times and due dates, determine the optimal processing sequence using (1) FCFS, (2) SPT, (3) EDD, and (4) CR. For each method, find the average job flow time and the average job tardiness. Jobs are listed in order of arrival.

Job	Job Time (hours)	Due Date (hours)
a	3.5	7
b	2.0	6
c	4.5	18
d	5.0	22
e	2.5	4
f	6.0	20

18. The Budd Gear Co. specializes in heat-treating gears for automobile companies. At 8:00 a.m., when Budd's shop opened today, five orders (listed in order of arrival) were waiting to be processed.

Order	Order Size (units)	Per Unit Time in Heat Treatment (minutes/unit)	Due Date (min. from now)
A	16	4	160
B	6	12	200
C	10	3	180
D	8	10	190
E	4	1	220

a. If the earliest due date rule is used, what sequence should be used?

b. What will be the average job tardiness?

c. What will be the average number of jobs in the system?

d. Would the SPT rule produce better results in terms of job tardiness?

19. The following table contains order-dependent setup times for three jobs. Which processing sequence will minimize the total setup time?

		Setup Time (hrs.)	Following Job's Setup Time (hrs.) A	B	C
Preceding Job	A	2	—	3	5
	B	3	8	—	2
	C	2	4	3	—

20. The following table contains order-dependent setup times for three jobs. Which processing sequence will minimize the total setup time?

		Setup Time (hrs.)	Following Job's Setup Time (hrs.) A	B	C
Preceding Job	A	2.4	—	1.8	2.2
	B	3.2	0.8	—	1.4
	C	2.0	2.6	1.3	—

21. The following table contains order-dependent setup times for four jobs. For safety reasons, job C cannot follow job A, nor can job A follow job C. Determine the processing sequence that will minimize the total setup time. (*Hint:* There are 12 alternatives.)