ISyE 3104 Fall 2005
HW12 – Answers

1. Precedence constraints are 5-6-7 and 1-2

Step 1. Among the candidates for the last position of the sequence, we have 2, 3, 4 and 7.
Total processing time of all jobs is 15+21+2+8+5+7+11=69.
As the objective is to minimize maximum tardiness, we compare the tardiness of these 4 candidates and pick the smallest tardiness candidate.
We obtain min{69-35, 69-48, 69-26, 69-57}= 12 that corresponds to job 7. Hence job 7 is scheduled last.

Step 2. Next we find the job scheduled prior to job 7.
Candidates are 2, 3, 4 and 6.
At this point the total processing time of the unscheduled jobs is 69-11=58.
Thus finding min{58-35, 58-48, 58-26, 58-53}=5 that corresponds to job 6. Hence job 6 is scheduled prior to job 7.
The current schedule is 6-7.

Step 3. New candidates are 2, 3, 4 and 5.
Total processing time of the unscheduled jobs is 58-7=51.
Thus finding min{51-35, 51-48, 51-26, 51-22}=3 that corresponds to job 3. Hence job 3 is scheduled prior to job 6.
Current schedule becomes 3-6-7.

Step 4. New candidates are 2, 4 and 5.
Total processing time of the unscheduled jobs is 51-2=49.
Thus finding min{49-35, 49-26, 49-22}=14 that corresponds to job 2. Hence job 2 is scheduled prior to job 3.
Current schedule becomes 2-3-6-7.

Step 5. New candidates are 1, 4 and 5.
Total processing time of the unscheduled jobs is 49-21=28.
Thus finding min{28-30, 28-26, 28-22}=(-2) that corresponds to job 1. Hence job 1 is scheduled prior to job 3.
Current schedule becomes 1-2-3-6-7.

Step 6. Final candidates are 4 and 5.
Total processing time of the unscheduled jobs is 28-15=13.
Thus finding min{13-26, 13-22}=(-13) that corresponds to job 4.

Therefore the minimum of the maximum tardiness occurs with the following sequence: 5-4-1-2-3-6-7. and the maximum tardiness is 14, which occurred for job 2.

2.

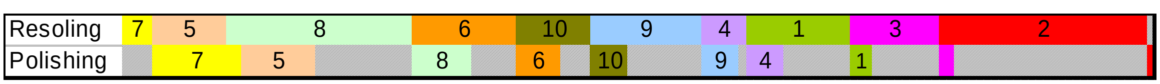
Job	Machine A	Machine B
1	1	11
2	9	2
3	10	6
4	5	12
5	13	4
6	3	16
7	15	7
8	8	14

By Johnson's algorithm, optimal sequence is obtained by starting to look at the minimum job times. If it appears in column A, then we schedule the job first, if it appears in column B, we schedule it last; and we cross out the row for that job. Continuing in this fashion the optimal scheduling is constructed.

For this problem the steps are as follows:

Step 1. minimum is 1 in column A, schedule job 1 first (1-   )
Step 2. minimum is 2 in column B, schedule job 2 last (1-   -2)
Step 3. minimum is 3 in column A, schedule job 6 next (1-6-   -2)
Step 4. minimum is 4 in column B, schedule job 5 last (1-6-   -5-2)
Step 5. minimum is 5 in column A, schedule job 4 next (1-6-4-   -5-2)
Step 6. minimum is 6 in column B, schedule job 3 last (1-6-4-   -3-5-2)
Step 7. minimum is 7 in column B, schedule job 7 last (1-6-4-   7-3-5-2)
Step 8. Schedule the final job (job 8) to construct the optimal (1-6-4-8-7-3-5-2)

3. Optimal solution to problem 8.38 is as follows:
7-5-8-6-10-9-4-1-3-2
Note that this schedule is not uniquely optimal. Jobs 4, 9, and 10 may be permuted in any order.
Let's draw the gannt chart of the first given optimal sequence: 7-5-8-6-10-9-4-1-3-2



Makespan of this gannt chart is 139 minutes, which is the minimum possible makespan.

4. The scheduling of baseball games in major league baseball (MLB) is a very complex scheduling problem that involves many different constraints. For instance there are constraints from the broadcasters' side who want the games at some special times of the days and in some special dates. From the teams perspective they don't want to play with the same team consequently (so-called semi-repeaters), or just doesn't prefer to play always home games or always away games. There are also many rules determined by the MLB involved in this large scale scheduling problem. Considering these rules plus trying to cut travel costs of teams that fly from this city to that is a very complex scheduling problem. One of the chaired ISyE Professors, Dr. George Nemhauser is currently scheduling the MLB games and he was lately on many newspapers about his work.

5. a.

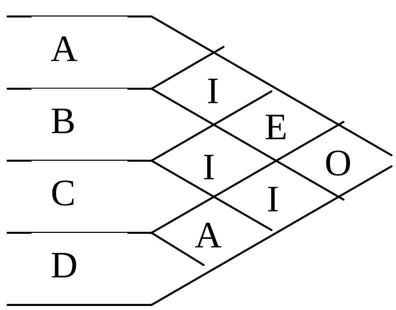
	A	B	C	D
A		8	24	0
B	0		28	16
C	0	0		52
D	0	0	0	

Routing	# of Batches
A-B-C-D	8
A-C-D	24
B-D	16
B-C-D	20

b.

	A	B	C	D
A		540	2268	0
B	0		1134	1104
C	0	0		5304
D	0	0	0	

c.



6. Each item in a fast-pick area requires an additional restock from storage. This is an additional cost. However, saving is achieved each time an item is picked from a fast-pick area, since the fast-pick area is closer to the order pickers and it is easier to find the correct item in fast-pick area. In order to profit, we need to balance these saving and cost parameters.

For some SKUs, it doesn't make sense to put them in the fast pick area, because their pick rate might be so low, so that it is more appropriate to leave the valuable fast-pick area to faster-moving SKUs to generate more savings.

There is an important ratio called viscosity, which is given by number of picks divided by square-root of the flow of an item. It turns out that higher viscosity items are more desirable in fast-pick area. So, the lower viscosity items are not generally eligible for fast-pick area.

7.

	A	B	C	D	E	F	G
SKU	picks/month	units/month	units/case	ft^3/ case	cases sold (B/C)	flow (ft3) (E*D)	viscosity (A/sqrt(F))
S	100	2000	10	4	200	800	3.54
T	150	1250	10	10	125	1250	4.24
W	400	4000	5	15	800	12000	3.65
X	400	1200	6	12	200	2400	8.16
Y	200	900	12	12	75	900	6.67

Therefore the viscosity ranking is X>Y>T>W>S.
The SKUs should go to the fast pick area in this order.

Consider putting only X into the fast-pick area.
Savings = 1*400 – 8*(2400/200)=400-96=304

Consider putting X and Y.
Sharing sqrt(2400)/ [sqrt(2400)+ sqrt(900)]= 62% of the 200 cubic feet to X, then Vx=124 and Vy=76.
Savings = 1*(400+200) – 8*(2400/124 + 900/76) = 350 > 304

Consider putting X, Y and T.
Sqrt(2400)/[sqrt(2400)+ sqrt(900)+sqrt(1250)]=42.9% to X >>>> 200*42.9%=85.8
Sqrt(900)/[sqrt(2400)+ sqrt(900)+sqrt(1250)]=26.2% to Y >>>>> 200*26.2%=52.4
Sqrt(1250)/[sqrt(2400)+ sqrt(900)+sqrt(1250)]=30.9% to T>>>>> 200*30.9%=61.8

Savings = 1*(400+200+150) – 8*(2400/85.8 + 900/52.4 + 1250/61.8) = 227 < 350

Therefore put only X and Y to the fast-pick area.

8. a.

1	2	3	4	5	6	7	8	9
SKU	units/month	units/case	ft^3/ case	cases sold	flow (ft3)	sqrt (flow)	allocated fraction	Allocated space (20*(8))
A	2200	200	2	11	22	4.69	8%	1.56
B	1100	6	7	183.333	1283.33	35.82	60%	11.94
C	3800	10	1	380	380	19.49	32%	6.50
					TOTAL	60.01	100%	20ft3

b. # of restocks = flow / space

1	2	3	4
SKU	flow (ft3)	Allocated space	# of restocks (2)/(3)
A	22	1.56	14.07
B	1283.33	11.94	107.48
C	380	6.50	58.49

Total restocks = 180.05

c. **Equal space allocation policy**

1	2	3	4
SKU	flow (ft3)	Allocated space	# of restocks (2)/(3)
A	22	6.67	3.30
B	1283.33	6.67	192.50
C	380	6.67	57.00

Total restocks = 252.80

Equal time allocation policy

1	2	3	4	5
SKU	flow (ft3)	Allocated fraction	Allocated space	# of restocks (2)/(4)
A	22	0.01305	0.261076	84.26
B	1283.33333	0.76147	15.22943	84.26
C	380	0.22547	4.509494	84.26
TOTAL	1685.33333	1	20	

Total restocks = 252.80

Both policies are performing 40% worse than the optimal policy.