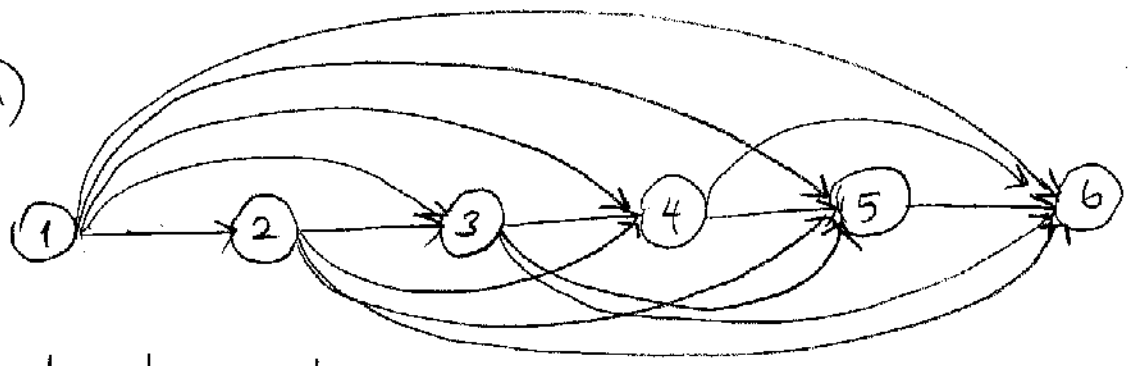
ISyE 3104
HOMEWORK #10
SOLUTIONS

Q. 1. a)



Assign costs to each arc c_{ij}

$c_{12} = 100$

$c_{13} = 100 + 50 = 150$

$c_{14} = 100 + 50 + 10.2 = 170$

$c_{15} = 100 + 50 + 10.2 + 50.3 = 320$

$c_{16} = 100 + 50 + 10.2 + 50.3 + 50.4 = 520$

$c_{23} = 100$

$c_{24} = 100 + 10 = 110$

$c_{25} = 100 + 10 + 50.2 = 210$

$c_{26} = 100 + 10 + 50.2 + 50.3 = 360$

$c_{34} = 100$

$c_{35} = 100 + 50 = 150$

$c_{36} = 100 + 50 + 50.2 = 250$

$c_{45} = 100$

$c_{46} = 100 + 50 = 150$

$c_{56} = 100$

Solution by Dynamic Programming

$f_6 = 0$

$f_5 = \min_{j>5} (c_{5j} + f_j) = 100$

$f_4 = \min_{j>4} (c_{4j} + f_j) = \min \begin{cases} c_{45} + f_5 = 100 + 100 \\ c_{46} + f_6 = 150 + 0 \end{cases}$ *

$= 150$ at $j = 6$.

$f_3 = \min_{j>3} (c_{3j} + f_j) = \min \begin{cases} c_{34} + f_4 = 100 + 150 \\ c_{35} + f_5 = 150 + 100 \\ c_{36} + f_6 = 250 + 0 \end{cases}$ *

$= 250$ at $j = 6$ (choose arbitrarily)

$f_2 = \min_{j>2} (c_{2j} + f_j) = \min \begin{cases} c_{23} + f_3 = 100 + 250 = 350 \\ c_{24} + f_4 = 110 + 150 = 260 \\ c_{25} + f_5 = 210 + 100 = 310 \\ c_{26} + f_6 = 360 + 0 = 360 \end{cases}$ *

$= 260$ at $j = 4$

$f_1 = \min_{j>1} (c_{1j} + f_j) = \min \begin{cases} c_{12} + f_2 = 100 + 260 \\ c_{13} + f_3 = 150 + 250 \\ c_{14} + f_4 = 170 + 150 \\ c_{15} + f_5 = 320 + 100 \\ c_{16} + f_6 = 520 + 0 \end{cases}$ *

$= 320$ at $j = 4$.

$y_1 = r_1 + r_2 + r_3 = 20 + 50 + 10 = 80$

$y_4 = r_4 + r_5 = 50 + 50 = 100$

} optimal policy $= (80, 0, 0, 100, 0)$ with a cost of \$320

b) $r = (20, 50, 10, 50, 50)$

$c = (40, 40, 50, 60, 30)$

lot-for-lot policy $\Rightarrow$ $y = (20, 50, 10, 50, 50)$

In week 2 and week 5, we exceed capacity. So, this plan is infeasible.

c) Cumulative requirements = $(20, 70, 80, 130, 180)$

Cumulative capacity = $(40, 80, 130, 190, 220)$

So, feasibility check is satisfied.

$r = (20, 50, 10, 50, 50)$

$30, 40, 20, 60, 30$

$r' = (30, 40, 20, 60, 30)$

$c = (40, 40, 50, 60, 30)$

r' is feasible.

Cost $\Rightarrow$ Setup cost = $5 \times 100 = \$500$

Holding cost = $10.1 + 10.1 + 20.1 = \$40$

Total = $\$540$

d)

Week	1	2	3	4	5
r'	30	40	20	60	30
c	40	40	50	60	30
y	30	40	20	60	30
Excess cap	10	0	30	0	0

Cost of shifting $= 30 \times 2$

Set-up cost $= 100$

$r'' = (30, 40, 50, 60, 0)$ with cost $\$460$

Q.2. a) MRP assumes that all required information is known with certainty. However, uncertainties are inevitable facts of any manufacturing environment.

Another important shortcoming of MRP is related with capacity planning. Even if lot sizes that are determined by MRP method, do not exceed the production capacities, there is no guarantee that when these lots are translated to gross requirements at a lower level, these requirements also can be satisfied with existing capacity. Therefore, a feasible production schedule at one level may result in an infeasible requirements at a lower level.

MRP is a static system. However, the production planning environment is dynamic.

System Nervousness is another shortcoming of MRP. MRP is expected to work in environments which do not have very significant demand uncertainties; i.e when demand variability is low.

b) MRP II attempts to incorporate the activities of a firm which are related with production into the production planning process. In particular, financial, accounting and marketing functions of the firm are tied to the operations function.

CRP (Capacity Requirements Planning) is the process by which the capacity requirements are placed on a work center or group of work centers are computed by using the output of the MRP planned order releases. Satisfying the feasibility in the production plan requires an iterative trial-and-error process between CRP and MRP.

c) JIT is a reactive system. If a problem occurs and the line stops, JIT reacts immediately. But MRP will not react so quickly. One of the reasons for this, is that, excessive inventories in MRP environment will mask the problem. Production lead times are shorter in JIT.

d) Little or no demand variability.
Reliable vendors
Small setup times for production

Q.3. a) SPT sequence minimizes mean flow time

- Sequence = 1 – 5 – 6 – 3 – 7 – 2 – 4
- Makespan = Sum of process times
  $= (1 + 2 + 3 + 4 + 6 + 7 + 8)$
  $= 31$
- Mean Flow time = $\frac{1 + 3 + 6 + 10 + 16 + 23 + 31}{7} = 12.86$

Sequence = (1 – 5 – 6 – 3 – 7 – 2 – 4)
Completion time = (1 – 3 – 6 – 10 – 16 – 23 – 31)
Due date = (25 – 11 – 4 – 15 – 8 – 21 – 12)
(4, 8, 21, 12 are marked with α)

- Maximum Lateness = 19
- # of Tardy jobs = 4.

b) Maximum lateness is minimized by EDD

- Sequence = 6 – 7 – 5 – 4 – 3 – 2 – 1
- Makespan = 31. (same).

Sequence = (6 – 7 – 5 – 4 – 3 – 2 – 1)
Completion time = (3 – 9 – 11 – 19 – 23 – 30 – 31)
Due Date = (4 – 8 – 11 – 12 – 15 – 21 – 25)
(8, 12, 15, 21, 25 are marked with α)

- Mean Flow time = $(3 + 9 + 11 + 19 + 23 + 30 + 31)/7 = 18$
- Max. lateness = 9
- # of Tardy jobs = 5

c) First order by EDD

Sequence = 6 – 7 – 5 – 4 – 3 – 2 – 1

Job	Process Time	Comp. time	Due Date
6	3	3	4
7	6	9	8 *

Put Job 7 at the end of the sequence.

Job	Process Time	Comp. time	Due Date
6	3	3	4
5	2	5	11
4	8	13	12 *

Put Job 4 at the end of the current sequence.

Job	Process time	Comp time	Due Date
6	3	3	4
5	2	5	11
3	4	9	15
2	7	16	21
1	1	17	25

Stop.

- Opt. Sequence is 6 – 5 – 3 – 2 – 1 – 7 – 4
- Makespan = 31
- Mean Flow time = $\frac{3+5+9+16+17+23+31}{7} = 14.86$
- Maximum lateness = 19
- # of tardy jobs = 2