SEQUENCING

In sequencing our aim is to find the order in which different jobs are to be processed on different machine so that the idle time is minimised and utilisation is maximised. It is essential for smooth flow of material and effective utilisation of man power and machine.

Roles or Assumption in Sequencing :

1) If nothing is mentioned the processing order for a m/c remain fixed.
2) One job on one machine at a time
3) Once a job is started it must be fully completed.
4) Time taken by the job while shifting from one m/c to another is negligible.
5) Irrespective of order, the processing time for the job remain constant.

N - Jobs on 1 machine :-

1) Job Flow Time : It is the time from some starting point untill that perticular job is completed.
2) Make Span time : It is the time from when processing begin on the first job in the set untill the last job is completed.
3) Tardiness / Lateness : It is the amount of time by which a job is delayed beyond its due date

4) Average no. of jobs in system :- It is the term used to represent avg. no. of jobs present all the time within the system untill one set of job is completed. It is the ratio of total job flow time over make span time.

Sequencing Rules for N job on 1 machine :-

i) Shortest Process Time (SPT)

Jobs are sequenced in increasing order of their process time i.e. minimum time first and maximum time in the last.

SPT	Job	Processing time	Due date	EDD
(2)	1	8	38	(2)
(1)	2	6	45	(4)
(3)	3	9	32	(1)
(5)	4	12	41	(3)
(4)	5	10	49	(5)

ii) Earliest Due Date (EDD)

Jobs are sequenced in increasing order of their due date.

iii) Critical Ratio Rule (CR)

$$CR = \frac{\text{Due date}}{\text{Processing Time}}$$

Jobs are sequenced in increasing order of their critical ratio.

iv) Slack Time Remaining (STR) rule

Slack time = Due date − Processing time

Jobs are sequenced in increasing order of their slack time remaining.

Q − A set of job are to be processed on a single m/c. obtain a sequence using SPT and EDD rule. Also determine make span time, job flow time for each job, avg job flow time per job, avg tardiness per job, avg. no. of job in system and no. of tardy jobs.

Jobs	Processing time	Due date
A	12	38
B	15	72
C	6	49
D	11	26
E	18	69
F	9	42
G	14	81
H	10	54

By SPT :-

Jobs	P.T	D.D	Total Job flow time	Tardiness
C	6	49	0 + 6 = 6	0
F	9	42	6 + 9 = 15	0
H	10	54	15 + 10 = 25	0
D	11	26	25 + 11 = 36	10
A	12	38	36 + 12 = 48	10
G	14	81	48 + 14 = 62	0
B	15	72	62 + 15 = 77	5
E	18	69	77 + 18 = 95	26

i) MST = 95

ii) C = 6 ; F = 15 ; H = 25 ; .....

iii) Average job flow time per job = Total Job flow time / No. of jobs

= 364/8 = 45.5 Least in SPT

iv) Average tardiness per job = Total tardiness / No. of jobs

= 51/8 = 6.375 min

v) Average no. of jobs in system = Total Job flow time / Make span time

= 364/95 = 3.83 Least in SPT

vi) No. of tardy job = 4 jobs

By EDD :-

Jobs	P. T.	D. D	Job flow time	Tardiness
D	11	26	0+11 = 11	0
A	12	38	11+12 = 23	0
F	9	42	23+9 = 32	0
C	6	49	32+6 = 38	0
H	10	54	38+10 = 48	0
E	18	69	48+18 = 66	0
B	15	72	66+15 = 81	9
G	14	81	81+14 = 95	14
			394	23

i) MST = 95

ii) D = 11, A = 23, F = 32 .....

iii) Avg job flow time per job = Total Job flow time / No. of Job

= 394/8 = 49.25

iv) Avg. tardiness per job = 23/8 = 2.875 EDD least.

v) Avg. no. of jobs in system = 394/95 = 4.14

vi). No. of tardy job = 2

Q - 4 jobs are to be processed on 1 m/c as per data.

i) Using SPT rule find total tardiness.

ii) Using EDD rule find the no. of jobs delayed.

Job	PT	D.D
1	4	6
2	7	9
3	2	19
4	8	17

N- Jobs on 2 Machine :-

These jobs are solved by johnson's rule or Johnson's algorithm

Steps :-

i) Find out the minimum of A_i and B_i

ii) If the minimum is for particular job on m/c A, then perform that job at the start.

iii) If the minimum for particular job on m/c B, then perform that job to the last.

iv) Strike off the job which is assigned so that it cant be assigned again.

v) Continue in the similar manner untill all the jobs are assigned

Jobs	A	B
1	(6)	8
2	9	(5)
3	10	7

1 - 3 - 2

Jobs	A	B
1	(6)	8
2	9	(6)
3	7	9

1 - 3 - 2

Jobs	A	B
1	8	7
2	5	9
3	5	7

3 - 2 - 1

Jobs	A	B
1	8	4
2	6	9
3	6	4

2 - 1 - 3

Q → Find the optimum sequence for the following set of jobs to be processed on 2 m/c. Also find MST, idle time for each machine and their % utilisation. Also prepare grantt chart for both the m/c.

Jobs	M/c I	M/c II
A	7	3
B	4	8
C	2	6
D	5	6
E	9	4
F	8	1

C	B	D	E	A	F

Job	m/c 1	m/c 2	m/c 1 In	m/c 1 Out	m/c 2 In	m/c 2 Out
C	2	6	0	2	2	8
B	4	8	2	6	8	16
D	5	6	6	11	16	22
E	9	4	11	20	22	26
A	7	3	20	27	27	30
F	8	1	27	35	35	36
	35	28				

Idle time m/c 2 -
2+1+5 = 8 min

MST = 36 min

Idle time = MST - working time

m/c I = 36 - 35 = 1 min

m/c II = 36 - 28 = 8 min

Percent Utilisation = $\frac{\text{working time}}{\text{MST}}$

m/c I = $\frac{35}{36} \times 100$ =

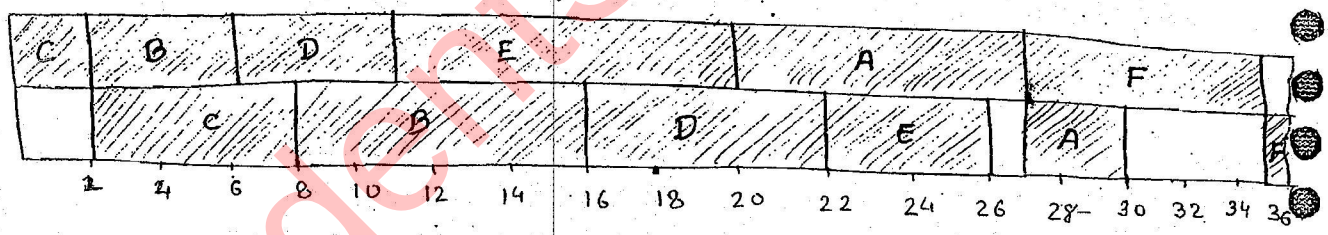
m/c II = $\frac{28}{36} \times 100$ =

Job flow time for E
= 26 min

→ m/c working

→ m/c idle

Gantt Chart -



Q → Find the optimum sequence for the following set of jobs also find MST and idle time for each m/c.

Jobs	m/c I	m/c II
A	2	6
B	5	8
C	9	4
D	4	7
E	6	3
F	8	9
G	7	3
H	5	8
I	4	11

A	D	I	B	H	F	C	G	E

Job	m/c 1	m/c 2	m/c 1		m/c 2	
			In	Out	In	Out
A	2	6	0	2	2	8
D	4	7	2	6	8	15
I	4	11	6	10	15	26
B	5	8	10	15	26	34
H	5	8	15	20	34	42
F	8	9	20	28	42	51
C	9	4	28	37	51	55
G	7	3	37	44	55	58
E	6	3	44	50	58	61
	60					

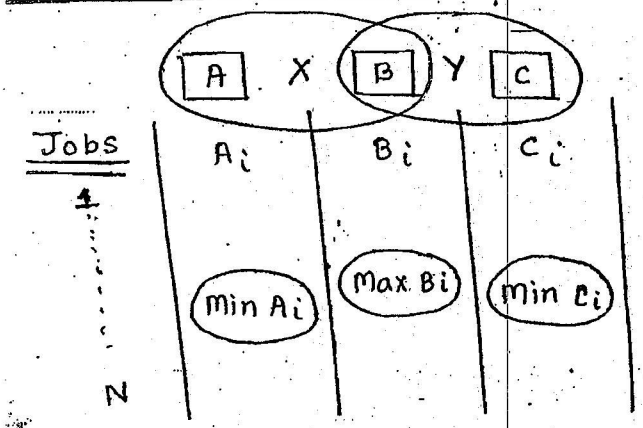
Make span time = 61

Idle time – m/c 1 = $61 - 50$ = 11 min.

m/c 2 = 2

Percent utilisation = $\frac{50}{61} \times 100$ m/c 1

N Jobs – 3 Machine →



condition for converting 3 m/c into 2 m/c –

i) Min $A_i \geq$ Max B_i

ii) Min $C_i \geq$ Max B_i

$X_i = A_i + B_i$

$Y_i = B_i + C_i$

Q – There are 5 jobs each of which must go through m/c in the same order. Find the optimum seq, MST and idle time for each machine.

Jobs	A	B	C
1	8	5	4
2	10	6	9
3	6	2	8
4	7	3	6
5	11	4	5

X	Y
13	9
16	15
18	10
10	9
15	9

Since Min $A_i \geq$ Max B_i

3	2	5	1	4

Job	A	B	C	A In	A Out	B In	B Out	C In	C Out
3	6	2	8	0	6	6	8	8	16
2	10	6	9	6	16	16	22	22	31
5	11	4	5	16	27	27	31	31	36
1	8	5	4	27	35	35	40	40	44
4	7	3	6	35	42	42	45	45	51
	42	20	32						

MST = 51 –

Idle time = A = 51 – 42 = 9

B = 51 – 20 = 31 → 6 + 8 + 5 + 4 + 2 + 6

C = 51 – 32 = 19 → 8 + 6 + 4 + 1