⇒ Sequencing

In sequencing our aim is to find the order in which different jobs are to be proced on different machine so there idle time is minimized and utilization is optimized. It is essential for smooth flow of material and effective utilization of man power and machine

Rule and assumption in sequencing :—

1) If nothing is mention processing order for machine remain fixed.
2) One job at one machine at a time.
3) Once a job is started it must be fully Completed
4) time taken by the job from one machine to another is negligible
5) irrecpective of model the processing time for the job remain costant.

N Jobs on one machine:-

Terms

1) Job flow time:- it is a time for some starting point until that particular job is completed.

2) Make span time (MST):- it is a time from when processing begain on the 1st job set until the last job is completed

3) Tardiness or lateness:- it is a amount of time by which a job is delayed beyonds its due date.

4) Average number of jobs in system:- it is a term used to represent average no. of job present all the time whithin the system until one set of job is completed it is the ratio of total job flow time over make span time ($\frac{\text{Total Job Flow time}}{\text{makespan time}}$)

Sequencing rules for N jobs on one machine:-

1) Shortest Processing Time (SPT)

In this rule jobs are process in increasing order of their processing time. That is minimum time first and maximum time in last.

Jobs	Processing time	Due Date	SPT	EDD
1	8	20	③	③
2	5	22	①	④
3	6	18	②	①
4	10	19	⑤	②
5	9	41	④	⑤

(2) Earliest due date (EDD Rule) :-

Jobs are sequence in increasing order of their due date.

(3) Critical Ratio Rule (CR)

$$CR = \frac{\text{Due Date}}{\text{Processing time}}$$

Jobs are sequenced in increasing order of their critical ratio.

(4) Slack Time Remaining (STR)

$$\text{Slack Time} = \text{Due Date} - \text{Processing time}$$

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

Problem (15) A set of job are to be process on a single machine ~~of sequence using~~ ... obtain sequence using SPT and EDD rule. Also determine MST, Job flow time for each job, Avg. Job flow time per Job, Average tardiness per Job, Avg. no of Jobs in system and no# of tardy Jobs

Jobs	Processing time	Due Date	SPT	EDD
A	11	58	-(4)	-(4)
B	6	49	-(1)	-(3)
C	17	78	-(8)	-(7)
D	12	88	-(5)	-(8)
E	9	44	-(2)	-(2)
F	16	65	-(7)	-(5)
G	15	70	-(6)	-(6)
H	10	38	-(3)	-(1)

Soln

SPT

Jobs	P.T.	D.D.	Job Flow time	Tardiness
B	6	49	0+6 = 6	0
E	9	44	6+9 = 15	0
H	10	38	15+10 = 25	0
A	11	58	25+11 = 36	0
D	12	88	36+12 = 48	0
G	15	70	48+15 = 63	0
F	16	65	63+16 = 79	14
C	17	78	79+17 = 96	18
			Sum = 368	Sum = 32

1) MST = 96

2) B - 6, E - 15, H - 25 - - -

3) Average Job flow time per Job = $\frac{\text{Total Job flow time}}{\text{No. of Jobs}} = \frac{368}{8} = 46.0$ Min in SPT

4) Average Tardiness per Job = $\frac{\text{Total tardiness}}{\text{No. of Jobs}} = \frac{32}{8} = 4.0$

5) Average number of Jobs in System = $\frac{\text{Total Job flow time}}{\text{MST}} = \frac{368}{96} = 3.82$ Min in SPT

6) No. of tardy Jobs = 2 Jobs

*

EDD

Jobs	P.T.	D.D.	Job flow time	tardiness
H	10	38	0+10=10	0
E	9	44	10+9=19	0
B	6	49	19+6=25	0
A	11	58	25+11=36	0
F	16	65	36+16=52	0
G	15	70	52+15=67	0
C	17	78	67+17=84	6
D	12	88	84+12=96	8
	96		389	14

(1) MST = 96

(2) H - 10 , E - 19 , B - 25 - - -

(3) Avg Job flow time per Job = $\frac{389}{8}$ = 48.625

(4) Avg. Tardiness per Job = $\frac{14}{8}$ = 1.75 least in EDD

(5) Avg. No. of Job in System = $\frac{389}{96}$ = 4.05

(6) No. of tardy Jobs = 2 Jobs

Problem (16) Gate 2010 :- Four Jobs are to be processed on a single machine as per data Given below

i) using EDD find No. of Jobs delayed

ii) using SPT find total tardiness.

Jobs	P.T. (days)	D.D.
1	4	6
2	7	9
3	2	19
4	8	17

Sol^{n}

(i) EDD

Jobs	P.T	D.D.	Job flow time	tardiness
1	4	6	0+4 = 4	0
2	7	9	11	2
4	8	17	19	2
3	2	19	21	2
				6 total tardiness

Three Jobs were delayed

(ii)

Jobs	P.T.	D.D.	Job flow time	tardiness
3	2	19	2	0
1	4	6	6	0
2	7	9	13	4
4	8	17	21	4
				8 total tardiness

tardiness = 8

N Jobs on Two machines :-

These problems solved by Johnson's rule or Johnson's algorithm and the steps involved are

(1) Find out the minimum of A_i and B_i

(2) If the minimum is for a particular Job on machine A, then perform that Job in the start.

(3) If the minimum is for a particular Job on machine B, then perform that Job in the last.

(4) strikeoff the Job which a assigned so that it cannot be considered again.

(5) Continue the similar manner until all the Job are assign

Problem (7) Find optimum sequence for the following set of Job. Also find make span time (MST), idle time for each machine and their percentage utilization. Also prepare Grantt chart for both the machine.

Jobs	M-I	M-II
A	7	3
B	4	8
C	2	6
D	5	6
E	9	4
F	8	1
	35	28

Sol^{n}

optimum sequence C B D E A F

Job	MC-I		MC-II	
	In	out	In	out
C	0	2	2	8
B	2	6	8	16
D	6	11	16	22
E	11	20	22	26
A	20	27	27	30
F	27	30	35	36

2+1+5 = 8 (MC-II idle time)

MST = 36 min.

Idle time = MST - working time

MC-I = 36 - 35 = 1 min

MC-II = 36 - 28 = 8 min

$$\text{Percentage utilization} = \frac{\text{working time}}{\text{MST}} \times 100$$

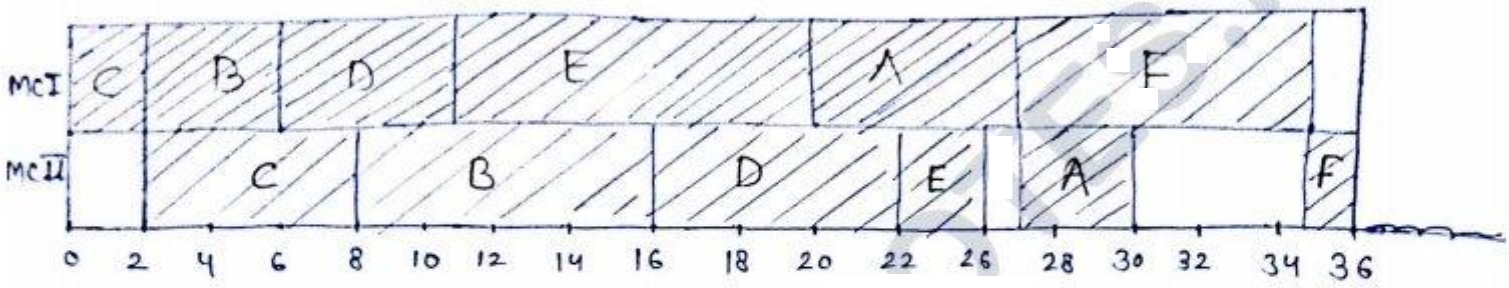
$$\text{MC-I} = \frac{35}{36} \times 100 = 97.22\%$$

$$\text{MC-II} = \frac{28}{36} \times 100 = 80\%$$

Job Flow time

C - 8, B - 16, D - 22, E - 26 - - - - - -

Grantt chart



▨ - mc working

□ - mc idle

Problem (18) find the optimum sequence for the following set of jobs to be processed on two machine. also find MST and idle time for each machine

Jobs	A	B	C	D	E	F	G	H	I	Sums
MC-I	3	6	5	10	7	9	8	6	5	59
MC-II	7	9	8	5	4	10	4	9	12	68

optimum sequence A C I B H F D G E

H B

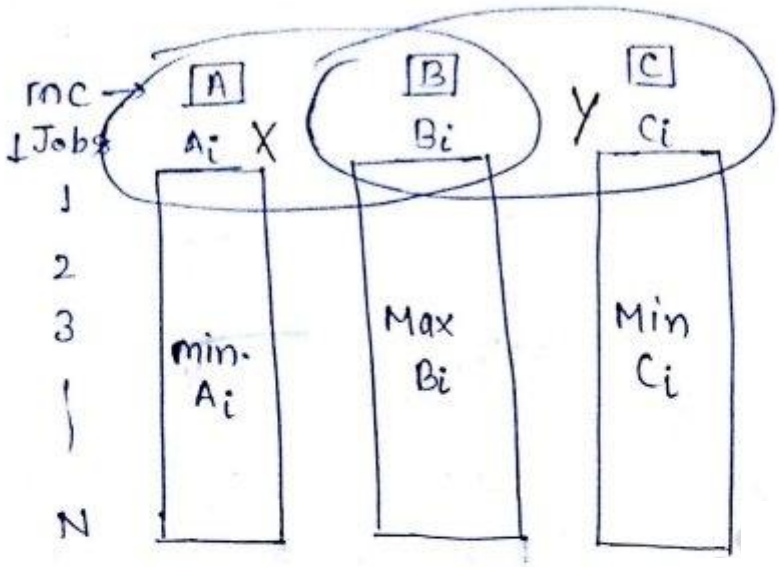
Jobs	MC-I		MC-II	
	in	out	in	out
A	0	3	③ 3	10
C	3	8	10	18
I	8	13	18	30
B	13	19	30	39
H	19	25	39	48
F	25	34	48	58
D	34	44	58	63
G	44	52	63	67
E	52	59	67	71

MST = 71 minute

idle time for MC-II = 71 - 59 = 12 min.

MC-I = 71 - 68 = 3 min.

N Jobs on three (3) machines :-



Two conditions must be satisfied

These two conditions must satified

1) Min. $A_i \geq$ Max. B_i

OR

2) Min $C_i \geq$ Max. B_i

$X_i = A_i + B_i$

$Y_i = B_i + C_i$

Problem (19) These are 5 Jobs each of which must go through machine A, B & C in same order. And optimum sequence, MST and idle time for each.

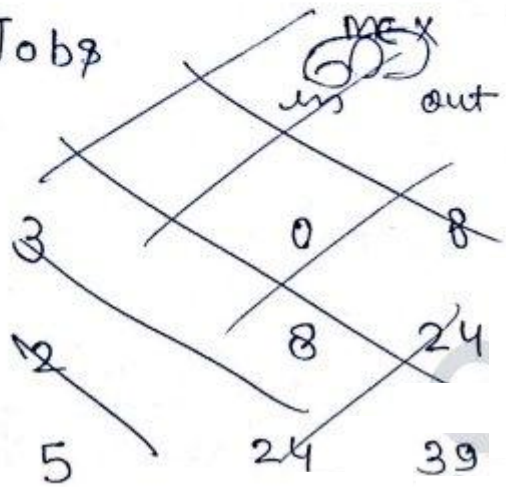
Jobs	1	2	3	4	5	Sum
A	8	10	6	7	11	42
B	5	6	2	3	4	20
C	4	9	8	6	5	32

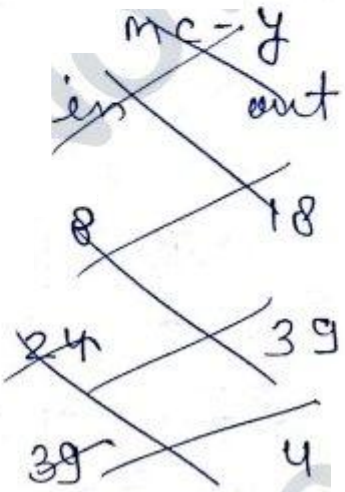
Sol) Min A_i = 6 Max B_i = 6

	1	2	3	4	5
X =	13	16	8	10	15
Y =	9	15	10	9	9

optimum sequence = 3 2 5 1 4

Jobs





Jobs	MC-A		MC-B		MC-C	
	in	out	in	out	in	out
3	0	6	6	8	8	16
2	6	16	16	22	22	13
5	16	27	27	31	31	36
1	27	35	35	40	40	44
4	35	42	42	45	45	51

MST = 51 min.

idle time MC-A = 51-42 = 9 Min.
MC-B = 51-20 = 31 Min
MC-C = 51-32 = 19 Min.