UNIT - V

Sequencing and Replacement :

Sequencing problem :

The section of an appropriate order for a series of jobs to be done on a finishing member of service facilites in some there assign order is called sequencing.

The procedure for a sequencing problem.

=> Each job once started on a machines is to be performed upto completion on that machine

=> The processing time on each machine is known such a time is independent of the order of the jobs in which their are to be process.

=> The time taken by each job inchanging over from one machine to another machine is negligible.

=> The job started on the machines as soon as the job and the machine both of idle and job is next to the machine and the machine is also next to job.

=> No machine may process more than one job simultaneously.

=> The order of completion of job has known significance (i.e) No job is to be given periority. The order of completion job is Independent of sequence of job

Basic terms and in sequencing:

(i) Number of machine:

The number of service facilities which a job must pass define it is assumed to be completed.

ii) Processing order:

The order (of sequence) in which given machines are required for completing the jobs.

iii) Processing time:

It indicates the time required by a jobs each machine

iv) Total Elapsal Time:

It the time of interval between starting the first job and completing the last job including the idle time. In a particular order by the given set of machines.

v) Idle time on a machine:

It is the time for which a machine does not have a job to process. That is idle time from the end of job (i-1) to the start of job i.

vi) No passing rule:

The rule of maintaining the order in which jobs are to be processed on given machine.

For examples:

If n jobs are to be processed through 3 machines M_1, M_2, M_3 in the order again

Ex: 1

(1) A company has 4 Job on hand Each of these must be processed in two department. the sequential order is A → B

Department		J_1	J_2	J_3	J_4
Department	: A (days)	8	6	5	1
"	: B (days)	8	3	4	5

find the sequence in which 4 Jobs should be processed so as to take minimum time to finish all the 4 Jobs.

Soln

Step 1: Consider the given problem.

Job	1	2	3	4
M_1	8	6	5	1*
M_2	8	3	4	5

find the sequence using Johnson's rule. the processing is

In → M_1 → M_2 → out

M_1 - 1st machine in the process M_2 - 2 machine in the process

Clearly the jobs must be processed in M_1 first and second to M_2 Next.

Step 2:

Select the minimum processing Time.

J_4			

the problem reduced to

Job	J_1	J_2	J_3
M_1	8	6	5
M_2	8	3	4

step 3 :

Repeat step - 2 until all Jobs are considered

J_4			J_2

then the problem reduced to

Job	J_1	J_3
M_1	8	5
M_2	8	4

J_4		J_3	J_2

Hence the optimal sequence is

J_4	J_1	J_3	J_2

Consider the table

Job sequence	Machine 1		Machine 2		Idle time for machine B
	in	out	in	out	
J_4	0	1	1	6	1
J_1	1	9	9	17	3
J_3	9	14	17	21	-
J_2	14	20	21	24	-

The minimum elapsed time T = 24 hrs

Idle time for machine A = 24 - 20 = 4 hrs

Idle time for machine B = 1+3 = 4 hrs

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J_1	J_5			

Step 3 :

Job	J_2	J_3	J_4
M_1	8	* 5	7
M_2	10	6	5

J_1	J_5	J_3		

Step 4 :

Job	J_2	J_4
M_1	8	7
M_2	10	* 5

J_1	J_5	J_3		J_4

Step 5 :

Job	J_2
M_1	* 8
M_2	10

J_1	J_5	J_3	J_2	J_4

Job	Machine A		Machine B		Idle Time for machine B
	in	out	in	out	
J_1	0	3	3	7	3
J_5	3	7	7	15	–
J_3	7	12	15	21	–
J_2	12	20	21	31	–
J_4	20	27	31	36	–

The minimum elaspad Time T = 36 hrs

he idle time for machine A = 36 - 27

= 9 hrs.

dle Time for machine B = 3 hrs.

Three machine problem

A company has six jobs which go through three machines, x, y and z in the order xyz. The processing time in minutes for each jobs on each machine is as follows.

Job	1	2	3	4	5	6
X	18	12	29	36	43	37
Y	7	12	11	2	6	12
Z	19	12	23	47	28	36.

What should be the sequence of the J[illegible] which that the total make span is minimized

Soln

In the given problem

minimum of x = 1[illegible]

Maximum of y = 12

minimum of z = 12.

Since min(x) ≥ max(y) for corresponding entries, we can convert three machines problem into two machines problem.

machine G : x + y

Machine H : y + z

Job	1	2	3	4	5	6
	25	24	40	38	49	49
	26	24	34	49	34	48

The optimum sequence is

J_2	J_1	J_4	J_6	J_3	J_5

Job machine	Machine x		machine y		machine z		Idle time for machine y	Idle Time for machine
	in	out	in	out	in	out		
J_2	0	12	12	24	24	36	12	24
J_1	12	36	30	37	37	56	6	1
J_4	30	66	66	68	68	115	29	12
J_6	66	103	113	115	115	151	35	—
J_3	103	132	132	143	151	174	17	—
J_5	132	175	175	181	181	209	32	7

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Total elapsed time = 209 hrs

Idle time for X = 209 - 175

X = 34 hrs

Idle time for Y = 12 + 6 + 29 + 35 + 17 + 32 + (209 - 81)

Y = 131 + 28

Y = 159 hrs.

Idle time for Z = 24 + 1 + 12 + 4

= 44 hrs.

5) five Job each of which must go through three machines A, B and C passing is ~~not allowed~~ Determine the order. A BC where passing is not allowed determine the optimum sequency of Job that minimize the total elapsed time when the following tables given the processing which follows.

Job	J_1	J_2	J_3	J_4	J_5
M - A	8	10	6	7	11
M - B	5	6	2	3	4
M - C	4	9	8	6	5

soln

In the given problem

minimum of M - A = 6

maximum of M - B = 6

minimum of M - C = 4

since min (M - A) max (M - B)

~~Job J_1 J_2 J_3 J_4 J_5 J_6~~

machine G = M - A + M - B.

machine H = M - B + M - C

Job	J_1	J_2	J_3	J_4	J_5
	13	16	*8	10	15
	*9	*15	10	*9	*9

J_3	J_2	J_4	J_1	J_5

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Jobs	Machine A		Machine B		Machine C		Idle time B	Idle time C
	in	out	in	out	In	out		
J_3	0	6	6	8	8	16	6	8
J_2	6	16	16	22	22	31	8	6
J_4	16	~~19~~ 23	23	26	31	37	1	-
J_1	23	31	31	36	37	41	5	-
J_5	31	42	40	46	46	51	6	5

Total elapsed time = 51 hrs

Idle time for x = 51 - 42 = 9 hrs

Idle time for y = 51 - 46 + 6 + 8 + 1 + 5 + 6 = ~~26~~ 31 hrs

Idle time for z = 8 + 6 + 5 = 19 hrs

Four machine problem:

(1) Slove the following sequency problem giving on optimal solution when passing is not allowed

Job Sequence	1	2	3	4	5
M_1	10	12	8	15	16
M_2	3	2	4	1	5
M_3	5	6	4	7	3
M_4	14	7	12	8	10.

... elapsed time.

Soln

The given problem is

min $M_1 = 8$

max $M_2 = 5$

max $M_3 = 7$

min $M_4 = 7$

min $(M_1) \geq$ max (M_2)

min $(M_3) \geq$ max (M_4)

machine G $= M_1 + M_2 + M_3$

machine H $= M_2 + M_3 + M_4$.

Job sequence	1	2	3	4	5
G	18	20	16	23	24
H	22	15	20	16	18

The optimum sequence is

J_3	J_1	J_5	J_4	J_2

Job	machine M_1		machine M_2		machine M_3		machine M_4		Idle time for machine M_2	Idle time M_3	Idle time M_4
	in	out	in	out	in	out	in	out			
J_3	0	8	8	12	12	16	16	28	8	12	16
J_1	8	18	18	21	21	26	28	42	6	5	–
J_5	18	34	34	39	39	42	42	52	13	13	–
J_4	34	49	49	50	50	57	57	65	10	8	5
J_2	49	61	61	63	63	69	69	76	11	6	4

Total elapsed time = 76 hrs

Idle time for M_1 = 76 - 61

= 15 hrs.

Idle time for M_2 = 76 - 62 + 8+6+13+11+11

= 81 hrs.

Idle time for M_3 = 76-69+12+5+13+8+6

= 51 hrs

Idle time for M_4 = ~~76~~- 16+5+4

= 25 hrs.

Grapical Method:

If we want to process two Jobs using m machines we can make use of the graphical method using two dimension normally the x axis refers to Job 1 processing time and y axis refers to Job 2 processing time.

The Required minimum Total elapsed Time = processing Time for Job 1 + Idle time of Job1 (OR) = Processing time of Job 2 + Idle time of Job 2.