Sequencing –

- Total processing time / elapsed time
  - Minimization model
- Shop floor
  - WIP (Product is waiting to be processed)
  - M/c is wating for product
    (Machine utilization)
- Machine utilization
  - Huge investment (Block capital, capital cost...)
  - ROR
- Machine utilization – as high as possible.

Theory question to be prepared

1. State the various assumptions in sequencing model.

Case 1st – Processing n jobs through two machines / 2 machines, n jobs problem.

Prob 1

A machine operator has to perform two operations – turning and threading on six jobs in the sequence turning and threading.

1. Determine the sequence in which job should be processed in order to minimize total time
2. Find out idle time of turning operation and threading operation.
3. Calculate percentage utilization of threading and turning machine.

Job	Time for turning (minutes)	Time for threading (minutes)
1	- 3	8
2	- 12	10
3	- 5	9
4	- 2	6
5	- 9	3
6	- 11	1

Solution

Job / M/c	1	2	3	4	5	6
Turning	3	12	5	2	9	11
Threading	8	10	9	6	3	1

The optimum sequence of jobs is.

4	1	3	2	5	6

1. Select the Least processing time if it is for M/c 1 then write the corresponding job number to extreme Left. and if it is for M/c 2, then write the corresponding job number to extreme right.

Job	Turning			Threading		
	t_{in}	t_{out}	t_{idle}	t_{in}	t_{out}	t_{idle}
4	0	2	-	2	8	2
1	2	5	-	8	16	-
3	5	10	-	16	25	-
2	10	22	-	25	35	-
5	22	31	-	35	38	-
6	31	42	-	42	43	4

Total elapsed time / total processing time = 43 minutes.

Idle time of turning m/c = (43-42) = 1 min

Idle time of threading m/c = 06 min

Percentage utilization of turning m/c

$$= \frac{(\text{Total elapsed time} - \text{Idle time})}{\text{Total elapsed time}} \times 100$$

$$= \frac{(43-1)}{43} \times 100 = \underline{97.67\%}$$

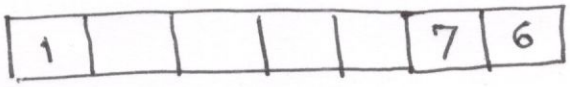
Similarly total elapsed time for threading m/c

$$= \frac{(43-6)}{43} \times 100 = \underline{86.04\%}$$

Prob2

There are seven jobs to be processed through machines A and B in the order AB. Find out the optimum sequence to minimize total processing time.

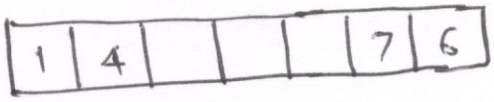
Job :	1	2	3	4	5	6	7
Machine A :	3	12	15	6	10	11	9
Machine B :	8	10	10	6	12	1	3



The reduced set of processing times becomes

Jobs :	2	3	4	5
Machine A :	12	15	6	10
Machine B :	10	10	6	12

Here minimum processing time is of 6 mins for M/C A as well as for m/c B, so there can be two possible sequence



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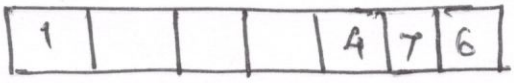
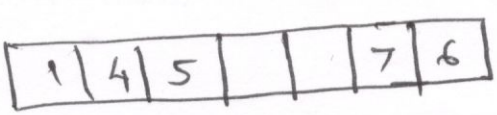


The reduced set of processing times becomes.

Jobs :	2	3	5
Machine A :	12	15	10
Machine B :	10	10	12



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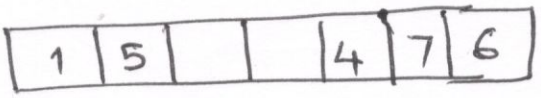

The reduced set of processing time

Jobs	2	3
Machine A	12	15
Machine B	10	10
	22	25

For 2nd M/c

Min – Right –

Max – Left –

1	4	5	3	2	7	6

or

1	5	3	2	4	7	6

Job	Machine A			Machine B		
	tin	tout	tidle	tin	tout	tidle
1	0	3	–	3	11	3
4	3	9	–	11	17	–
5	9	19	–	19	31	2
3	19	34	–	34	44	3
2	34	46	–	46	56	2
7	46	55	–	56	59	–
6	55	66	–	66	67	7

Total elapsed time = 67 mins.

Idle time for M/C A = (67-66) = 1 min.

Idle time for M/C B = (3+2+3+2+7) = 17 mins.

Case 2nd :- 3 machines and n jobs

Prob 3

Jobs	:	1	2	3	4	5	6
Machine A	:	3	12	5	2	9	11
Machine B	:	8	6	4	6	3	1
Machine C	:	13	14	9	12	8	13

Min A = 2 Max B = 8 Min C = 8

Min A $\geq$ Max B or

Min C $\geq$ Max B

Solution :-

1. As Min C (8) $\geq$ Max B (8), The problem can be Solved.
2. Converting 3 m/cs problem to 2 m/c problem as below

M/C x = M/C A + M/C B

M/C y = M/C B + M/C C

Job	:	1	2	3	4	5	6
Machine x	:	11	18	9	8	12	12
Machine y	:	21	20	13	18	11	14

4	3	1	6	2	5

Job	Machine A			Machine B			Machine C		
	tin	tout	tidle	tin	tout	tidle	tin	tout	tidle.
4	0	2	-	2	8	2	8	20	8
3	2	7	-	8	12	-	20	29	-
1	7	10	-	12	20	-	29	42	-
6	10	21	-	21	22	01	42	55	-
2	21	33	-	33	39	11	55	69	-
5	33	42	-	42	45	3	69	77	-

Total elapsed time = 77 mins.

Idle time for m/c A = (77-42) = 35 mins.

Idle time for m/c B = (77-45) + (2+1+11+3) = 32 + 17 = 49 mins.

Idle time for m/c C = 8 mins.

% age utilization of M/C A = $\frac{77-35}{77} \times 100 = 54.54\%$

% age utilization of M/C B = $\frac{77-49}{77} \times 100 = 36.36\%$

% age utilization of m/c C = $\frac{77-8}{77} \times 100 = 89.61\%$

Case 3 – m machines & n jobs

Prob4

Four jobs 1, 2, 3 and 4 are to be processed on five M/Cs A, B, C, D, and E in order A B C D E. Find out total processing time and idle time for each machines.

Job \ M/c	A	B	C	D	E
1	7	5	2	3	9
2	6	6	4	5	10
3	5	4	5	6	8
4	8	3	3	2	6

Solution

Condition

Min of first or last m/c should be ≥ Max of in between machines.

Min A = 5 Max B = 6, Max C = 5, Max D = 6 Min E = 6.

Min A (5) ≥ Max (B, C) (6, 5) ✗ or

Min E (6) ≥ Max (B, C)

Con While converting more than 2 m/cs problem to 2 machines problem

Add

M/C 1 = First to last but one (exclude last M/c)

M/C 2 = Second to last M/C (exclude first M/c

∴ Converting given problem to 2 M/c problem

M/C x = M/C A + M/C B + M/C C + M/C D

Job / Mic	1	2	3	4
Machine X	17	21	20	16
Machine Y	19	25	23	14

∴ The optimum sequence will be

1	3	2	4

Answers

∴ Total elapsed time = 51 mins.

Idle time A = 51 − 26 = 25 mins.

B = 7+2+2 + (51−29) = 33 mins.

C = 12+2+3+1+(51−32) = 37 mins.

D = 14+4+1+(51−35) = 35 mins.

E = 17+1 = 18 mins.