

ISE 5264
Modelling and Analysis of Semiconductor Manufacturing

ASSIGNMENT I

TEAM MEMBERS

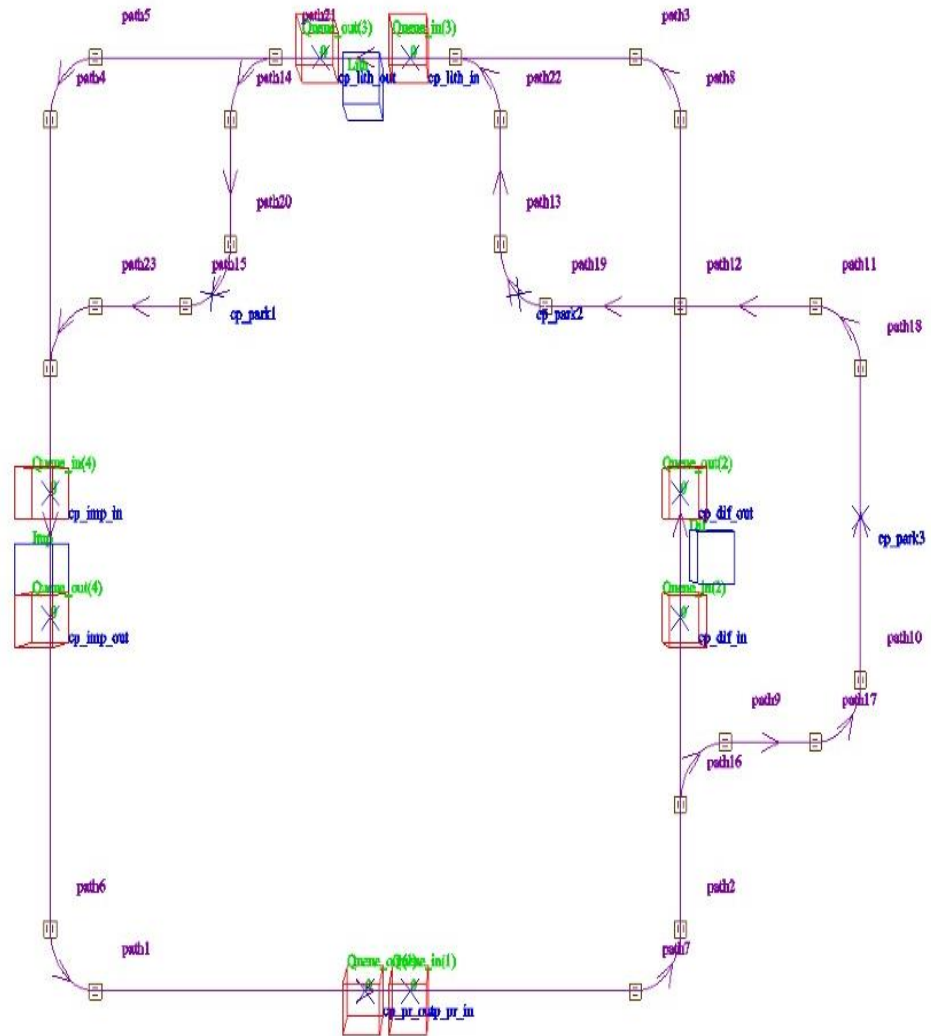
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On My honor, as a hokie, I have neither given nor received unauthorized aid on this work.

FAB LAYOUT



SIMULATION CODE

begin P_Enter_A arriving procedure

 move into Queue_in(1)

 set Makespan to ac

 send to P_Proc_A

end

begin P_Proc_A arriving procedure

 move into AGV.cp_pr_in

 travel to AGV.cp_dif_in

 move into Queue_in(2)

 use Dif for 225 min

 move into Queue_out(2)

 move into AGV.cp_dif_out

 travel to AGV.cp_lith_in

 move into Queue_in(3)

 use Lith for 30 min

 move into Queue_out(3)

 move into AGV.cp_lith_out

 travel to AGV.cp_imp_in

 move into Queue_in(4)

 use Imp for 55 min

 move into Queue_out(4)

 move into AGV.cp_imp_out

 travel to AGV.cp_lith_in

 move into Queue_in(3)

 use Lith for 50 min

 move into Queue_out(3)

 move into AGV.cp_lith_out

 travel to AGV.cp_dif_in

 move into Queue_in(2)

 use Dif for 255 min

 move into Queue_out(2)

 move into AGV.cp_dif_out

 travel to AGV.cp_imp_in

 move into Queue_in(4)

 use Imp for 10 min

 move into Queue_out(4)

 travel to AGV.cp_pr_out

 set Makespan to ac - Makespan

 print this load, " Cycle Time Load A = " Makespan to message

 send to die

end

Simulation Assumptions:

1. Queue in Capacity = 2
2. Queue out Capacity = 2
3. Vehicle capacity= 1

The model is simulated using the above-mentioned assumptions to achieve the least cycle time of all wafers possible.

QUESTIONS:

A total of 10 wafers are processed in the XYZ Fab. All 10 wafers undergo the same process flow.

Q1. Determine the Makespan when the parking spot of the vehicle is set at Pt1, Pt2 or P3.

Answer1:

Parking Station	Makespan
Station 1	2424.92 minutes
Station 2	2425.28 minutes
Station 3	2425.57 minutes

Q2. Which parking spot or a combination of two parking spots gives the best makespan?

Answer 2:

Parking Station	Makespan
Station 1	2424.92 minutes
Station 2	2425.28 minutes
Station 3	2425.57 minutes
Station 1,2	2424.92 minutes
Station 2,3	2425.28 minutes
Station 1,3	2425.57 minutes

From various parking stations and combination of stations it is observed that **Parking station 1** and a **combination of Station1,2** give the best makespan.

Q3. Which station is the bottleneck? Also, give the utilization of the bottleneck station.

Resources Report

File

Edit

View

Breakpoints

Sort

Since Reset: 169:23:00:00.00

T	B	Name	Total	Cur	Average	Capacity	Max	Min	Util	Av_Time	Av_Wait	Status	State
		Dif	2000	0	1.96	2	2	0	0.981	14400.00	0.00	Up	----
		Imp	2000	0	0.27	1	1	0	0.266	1950.00	190.15	Up	----
		Lith	2000	0	0.33	2	2	0	0.163	2400.00	0.00	Up	----

Find

Since diffusion does not have any idle time i.e it is continuously working without any gap which makes utilization near to 100 %. Since there is idle time for both litho and imp workstation, the utilization of these would be less than the utilization of diffusion workstation. Hence the diffusion workstation is the bottleneck.

Q4. Given your answer to Q.2 above, what will be the makespan if the number of machines at the Diffusion station is increased by 1 unit?

Answer 4:

If the number of machines at the Diffusion station is increased by a unit, i.e there are now 3 machines at diffusion station, the makespan is **1709.92 minutes**. Adding an additional resource at the bottleneck station results in a huge decrease in the makespan.

Q5 Given your answer to Q.2 above, what will be the makespan if the number of machines at the Implantation station is increased by 1 unit?

Answer 5:

If the number of machines at the Implantation station is increased by a unit, i.e there are now 2 machines at diffusion station, the makespan is **2415.17 minutes**.

Q6 Given your answer to Q.2 above, what will be the makespan if the number of machines at the Lithography station is increased by 1 unit?

Answer 6:

If the number of machines at the Implantation station is increased by a unit, i.e there are now 3 machines at diffusion station, the makespan is **2424.92 minutes**.

MACHINE FAILURES

A total of 1000 wafers are processed in the XYZ Fab. All 1000 wafers undergo the same process flow. [A] All 1000 wafers are available at the start of the simulation.

Q1. What is the makespan?

Answer1:

Makespan = 240356.11 minutes

Q2. Suppose the machines undergo periodic failures, and the Mean Time to Failure (MTTF) is 50 hours and the Mean Time to Repair (MTTR) is 50 hours for each machine at each station. What is the makespan now?

Answer 2:

Makespan = 480356.1 minutes

Q3. Assume the machines undergo periodic failures. Fill in the following table and plot graphs to reveal trends in makespan variation for various combinations of MTTR and MTTF. Also, plot graphs of makespan variation if MTTF is increased keeping MTTR constant, and then, if MTTR is increased keeping MTTF constant? Which variation is more dominant in impacting the makespan?

Answer 3: The graph below has measurements in minutes.

	MTTR	10	20	30	40	50
MTTF						
10		480356.1	720356.1	960356.1	1200356.1	1440356.1
20		360356.1	480356.1	600406.65	720356.1	840356.1
30		320156.1	399956.1	479756.1	559556.1	639356.1
40		300356.1	360356.1	420356.1	480356.1	540356.1
50		288356.1	336356.1	384356.1	432356.1	480356.1

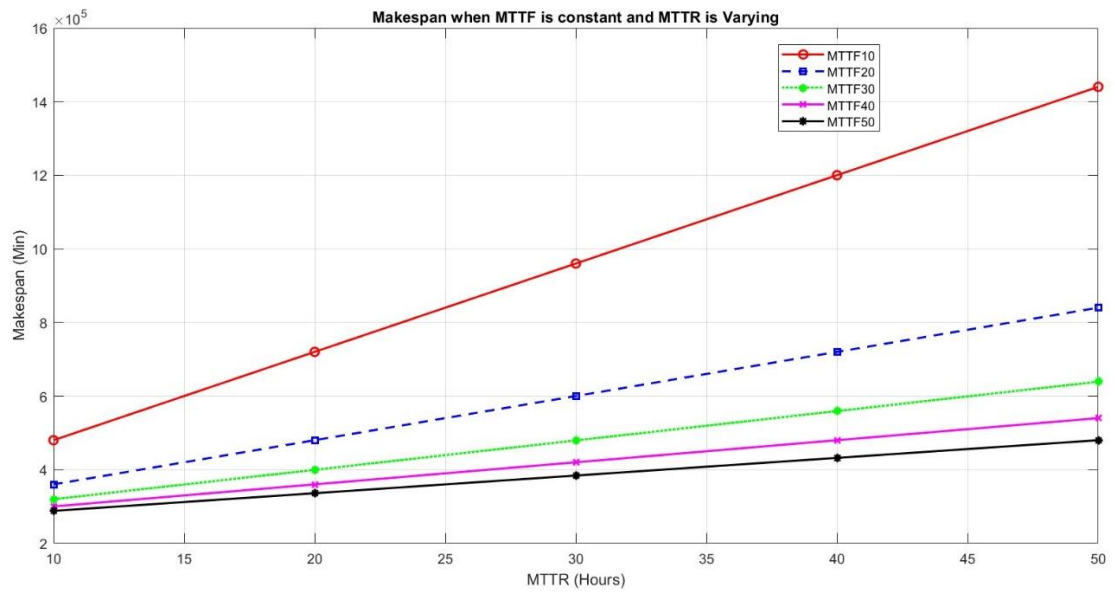


Figure 1: Makespan when MTTF is constant and MTTR is varying.

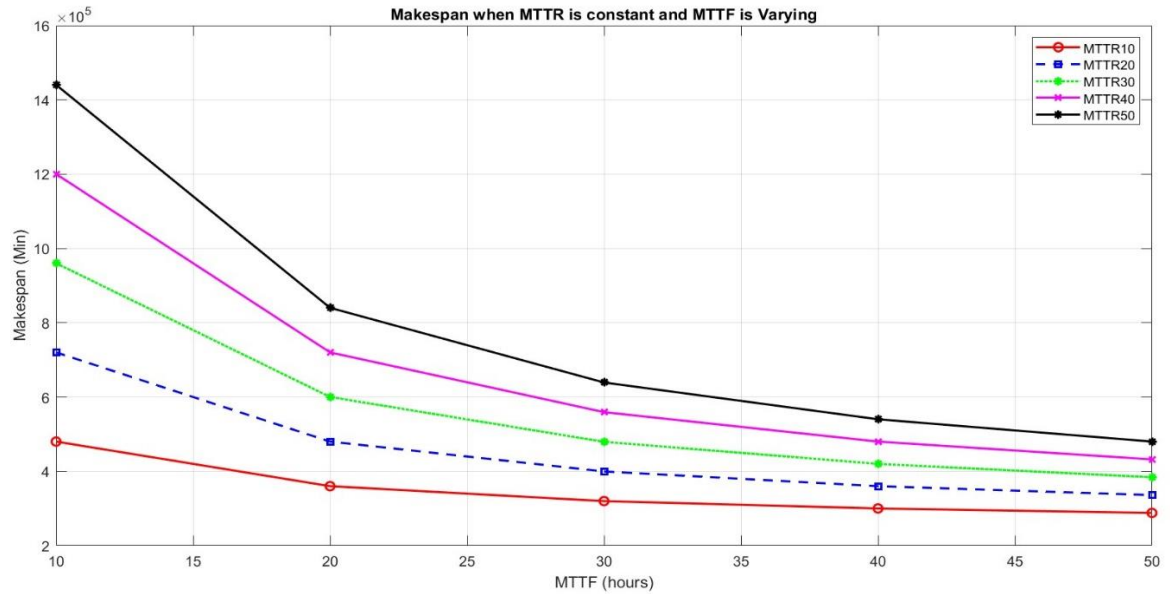


Figure 2: Makespan when MTTR is constant and MTTF is varying.

Q4. Does the makespan depend only on the ratio MTTF/MTTR or do the individual values of MTTF and MTTR play a roll as well? To investigate this, calculate makespans for various values of MTTF and MTTF when the ratio MTTF/MTTR equals 1 and 2. What inference can you draw from these results?

Yes, based on the table of the different MTTF and MTTR values, the makespan depends only on the ratio MTTF/MTTR when compared to the individual values of MTTF and MTTR. This allows you to use the ratio directly to determine the makespan. The graph below explains the above assertion.

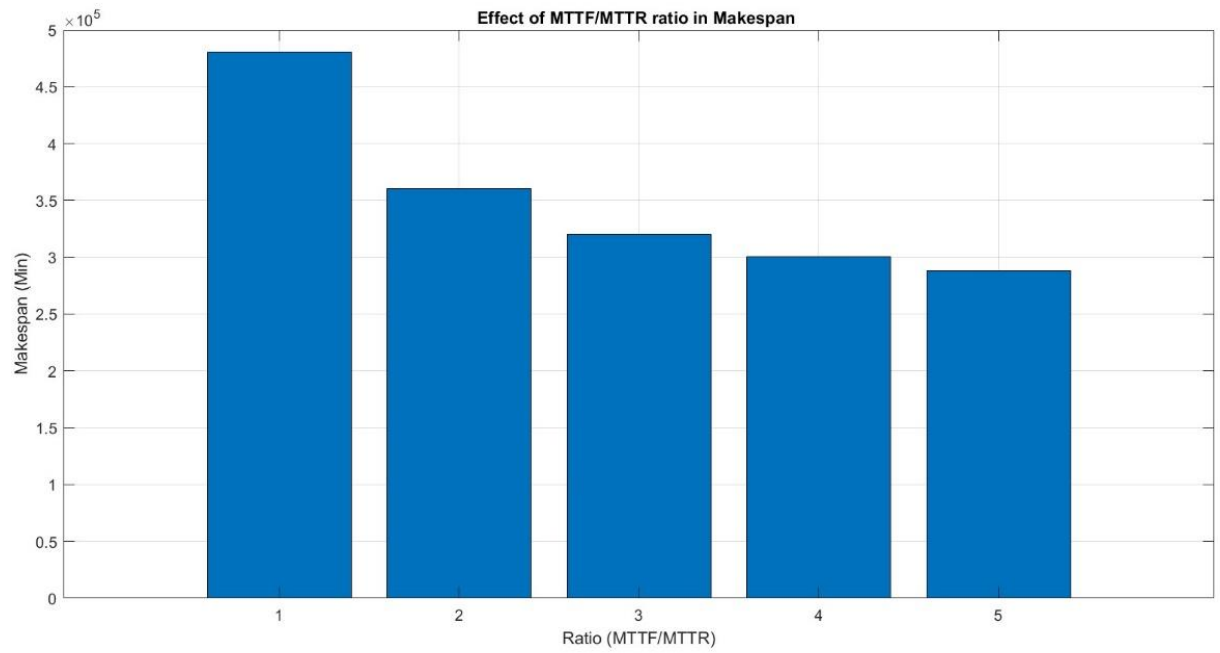


Figure 3: Makespan Vs Ratio (MTTF/MTTR)

STOCHASTICITY

[B] A total of 1000 wafers are processed in the XYZ Fab. All 1000 wafers undergo the same process flow. The wafer start rate is 1 wafer every 0.5 hours. Also, the mean values of the MTTF and MTTR are 50 hours for all the machines.

Q1. Determine the makespan.

Answer1:

Makespan= 480391.11 min

Q2. Now, assume the MTTF to be a random variable, which is normally distributed. Determine the makespan if the standard deviation is the following percentage of the mean.

- A. 0%**
- B. 20%**
- C. 30%**

Answer 2:

A. 0%	N/A
B. 20%	1094996.52 min
C. 30%	1165964.18 min

Q3. Next, assume the MTTR to be a random variable, which is normally distributed. Determine the makespan if the standard deviation is the following percentage of the mean.

- A. 0%**
- B. 20%**
- C. 30%**

Answer 3:

A. 0%	N/A
B. 20%	1116244.75 min
C. 30%	1171786.83 min

Q4. Next, assume both MTTF and MTTR to be random variables, which are normally distributed. Determine the makespan if their standard deviations are the following percentages of the mean.

- A. 0%**
- B. 20%**
- C. 30%**

Answer 4:

A. 0%	N/A
B. 20%	1108880.17 min
C. 30%	1182979.99 min

Q5. Now, consider variability in wafer arrival. Suppose the wafer arrival is normally distributed with the mean of 0.5 hours. Determine the makespan if the standard deviation is the following percentage of the mean.

A. 20%

B. 30%

Answer 5:

A. 20%	480431.756 min
B. 30%	480428.34 min

Q6. Next, consider variability in the processing times at all the stations, which are normally distributed with mean equal to their deterministic processing time values. Determine the makespan if the standard deviation of each processing time is the following percentage of the mean:

A. 20%

B. 30%

Answer 6:

A. 20%	480428.34 min
B. 30%	480428.34 min

Model One Drive Link

https://drive.google.com/drive/folders/10nSqMi3N6t_IyAwX2iH0nhv3aKcmbFuX?usp=sharing