IEOR 130 Final Examination
Spring, 2003
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Open book and notes. Work all problems. 20 points each problem, 120 points total.

1. For a particular semiconductor product, the customer orders received are as follows, sorted by date due to ship to customer:

Delivery date	1	2	3	4	5	6
Total orders due	140	100	140	135	70	80

The current finished goods inventory of the product is 200 units. The production plan for the product is as follows:

Output date	1	2	3	4	5	6
Output quantity	100	80	100	70	60	100

(a) A new customer calls and asks for delivery of 10 units in period 2, 10 units in period 3 and 10 units in period 5. Can the company provide delivery as requested?

(b) Calculate the best delivery schedule the company can offer the customer.

(c) Assuming the customer accepts the quote you calculated in part (b), calculate the new available-to-promise (ATP) quantities by period.

(d) Now suppose that because of yield problems, the output quantity in period 5 is reduced to 50 (instead of 60). How does the quote to the new customer change?

2. In a 24-hour period, a particular photo exposure machine had 2.5 hours of down time. Its rate efficiency was 85 percent. It completed processing of 35 lots, but 5 of these were the second run on a lot previously processed (i.e., 5 lots were reworked). The average process time per machine cycle was 0.5 hours. (One lot is processed per machine cycle, and a rework lot takes the same amount of time as a first-pass lot.)

(a) Estimate the availability, the utilization of availability and the OEE of the machine for that 24-hour period.

(b) An engineering change to the machine is under consideration. The change will reduce the rework rate to about 6 percent, but it will increase the average process time by 2 percent. (Theoretical process time will not be changed.) Estimate what the OEE score would have been for that 24-hour period if the engineering change had been implemented. Assume the number of lots processed will be increased just enough so that the utilization of availability is held constant.

(c) Now suppose it is not known how low the rework rate will be after the engineering change, but it is known that average process time would rise by 2 percent. Find the upper limit on the rework rate after the change such that the engineering change will not decrease OEE from its value in part (a). Once again, assume the utilization of availability is held constant.

3. The number of particles deposited on wafers at a particular process step is subject to statistical process control. The upper control limit is 80 particles. The upper specification limit is 70 particles, i.e., wafers with 70 or more particles deposited on them are scrapped.

(a) What kind of control chart should be used to track this parameter? Assume in the following questions that this kind of chart is in use.
(b) What is the process performance index for this step?
(c) What is the yield of this process step?
(d) To raise the yield of this step to 98%, what value for the process performance index must be achieved?

4. A diffusion furnace performs polysilicon depositions on four lots of wafers in one machine cycle. A machine cycle lasts 8 hours. At the start of the machine cycle, the load lock of the furnace is pumped down to vacuum. The load lock to the furnace incorporates an O ring that is subject to failure. When the O ring fails, all 4 lots become contaminated and must be thrown out. It is not possible to determine if the O ring has failed until after the machine cycle is completed, at which point it is obvious if the O ring failed or not.

When the O ring fails or when it is replaced before failure, it takes 12 hours to replace it and re-qualify the furnace for more production.

Data on O ring lifetimes is as follows:

# of furnace cycles, *n*	fraction that fail in cycle *n*
1	.10
2	.15
3	.20
4	.30
5	.25

(a) Suppose the furnace is the bottleneck and it never has any idle time. In order to maximize the output rate, after how many furnace cycles should a planned replacement of the O ring occur?

(b) Now suppose the furnace is not the bottleneck and it has considerable idle time. Will the best number of cycles until a planned O ring replacement become larger, or will it become smaller? Explain briefly. Do not solve numerically.

5. A fabrication process includes three steps performed on the bottleneck equipment type. Layer 1 of the process ends at the first bottleneck step; layer 2 ends at the second bottleneck step; layer 3 ends at the third bottleneck step; and layer four includes all steps of the process after the third bottleneck step. Data on cycle times is as follows:

Layer i	Actual Avg. Cycle Time (ACT_i)	Standard Deviation of ACT_i (σ_i)	Theoretical Cycle Time (SCT_i)
1	8.4	2.1	4
2	11.1	2.9	5
3	13.3	3.0	7
4	7.2	1.5	4

Management of the factory operating the process has decided to set the target cycle time for the process to be 90% of the actual average cycle time (ACT). The total WIP level in the process in the most recent week was 400.

(a) According to management’s target cycle time for the process, what is the target for the total WIP in the process?

(b) Compute efficient target WIP levels for each layer.

(c) Instead of your answer to (b), suppose management decides to set the target WIP level in each layer to be 90% of the actual WIP level in that layer. Also, suppose each bottleneck step is performed by a different machine. If management implements their target WIP levels, which of the three bottleneck layers will experience the least starvation of its bottleneck machine? And in this layer, will the amount of starvation be higher or lower than it would be using the target WIP levels in your answer in (b)? Explain. If you the see the idea, a relatively short calculation and explanation is sufficient to answer both questions.

6. In a particular fabrication process, the numbers of defects contributed by machine types 1 and 2 fluctuate from lot to lot. The total number of defects contributed by all other machine types is stationary. Assume that the *fraction* of the defects contributed by each machine type that are fatal is stationary, although this fraction is likely different for different machine types. A particular die type in production has an area of 0.4 sq cm. Data on yield and defects deposited on the wafers in several different production lots of this die type are as follows:

Lot number	Die yield	Avg. defects deposited per sq cm	
		Machine type 1	Machine type 2
1	0.90	.20	.50
2	0.88	.50	.50
3	0.92	.50	.10

Determine the fraction of defects that are fatal from machine type 1and from machine type 2.

Have a nice summer!