IEOR 130 Midterm Examination
Spring, 2004
Prof. Leachman

Open books and notes. Work all problems. 20 points each problem, 60 points total.

1. The number of particles deposited on wafers at a particular process step is subject to statistical process control. The upper control limit is 60 particles. The upper specification limit is 50 particles, i.e., wafers with 50 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? (Hint: Use the quadratic formula.)
(c) What is the yield of this process step? (Assume the only yield loss mechanism is particles.)
(d) To raise the yield of this step to 95%, what value for the process performance index must be achieved?

2. In a stacked wafer map of a 200mm wafer printed with 1000 die, the die site with the maximum observed yield has a yield equal to 85%.

(a) Estimate the baseline defect-limited yield. (Hint: use the quadratic formula.)

(b) Suppose fatal baseline defect density is reduced by 0.05 per sq cm. Suppose the die size is 0.5 sq cm. Predict the new maximum observed yield.

3. 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 unreliable O ring. When the O ring fails, all four 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 2 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 that the fab starts rate averages 6 lots per day and suppose that there is no yield loss before the polysilicon deposition step. What is the average utilization of the furnace?

(b) Suppose O ring replacement is planned to occur after completion of *t* furnace cycles, and suppose planned and unplanned replacement of O rings are the only types of down time for the furnace. Briefly explain why the expected time between O ring replacements must be twice the expected time between replacements that is consumed by furnace cycles. (Hint: use your answer to part (a).)

(c) We wish to determine the best frequency for planned replacement of the O ring. What is the most appropriate objective function to use for this decision? Express the objective function in terms of the problem data.

(d) What is the best frequency for planned replacement of the O ring?