EE 330

Homework 2

Fall 2020

Due Friday August 28

Problem 1

Assume a die has no soft fault vulnerability. Its area is $1.75cm^2$ and a process during its manufacturing has a defect density of $2cm^{-2}$. Given this information:

a) Determine the hard yield.
b) Determine the manufacturing cost per good die if 12" wafers are used and if the cost of the wafers is $1750.
c) Is this a good process? Given the hard fault probability is this expected?

Problem 2

Assume a die has no soft fault vulnerability and the defect density is $1.5cm^{-2}$.

a) If a die has a yield of 5% , determine the area of the die.
b) If the cost per fabricated die is $5 and the wafer cost is $810.73, what diameter are the wafers?

NOTE: There was an error in the posting of this homework problem and it has now been corrected. Part b) was originally stated as the "cost per good die is $5" and the yield is 5%. Under these conditions, the diameter of the wafer would have been unrealistic of what is or could be available in the industry.

Problem 3

You are an engineer working on IC fabrication for a large semiconductor company. You are a told that a new circuit for a Delta-Sigma ADC is in the works and that its die is anticipated to have an area of $0.75mm^2$. You also know that wafers processed at your fab house tend to have a defect density of $1cm^{-2}$ and, according to your colleague, the chip is anticipated to a soft yield of approximately 99%.

a) What do you expect the die's hard yield to be?
b) What do you expect the die's overall yield to be?
c) The semiconductor company you work for has a policy of not fabricating die that have a lower than 95% yield. As spec'd, is the ADC suitable to be produced at your fab location? If so, how much larger could the designers let the die area be before falling below the 95% yield limit? If not, how low of a defect density would a fab location need to be able to achieve the 95% yield?

Problem 4

You work for a company that designs integrated circuits but does not perform their own fabrication; instead, you have contracts with a number of vendors who fabricate for you. You are planning the development of a new IC which is anticipated to have a die-size of $0.85cm^2$. You asked four of your vendors who are capable of fabricating in your specific CMOS process to provide information regarding the available wafer sizes, wafer costs, and defect densities. They return the following information to you:

Vendor #	1	2	3	4
Wafer Diameter (cm)	45	30	30	25
Wafer Cost($/Wafer)	3900	1500	1450	1000
Defect Density (cm^{-2})	1	1.2	1.3	1.3

Which vendor would provide the lowest cost per good die? You may assume that the soft yield (Y_S) for all vendors is 100%.

Problem 5

Given a die with an area of 1cm^2 and defect density of 0.1cm^{-2} and a soft yield of 80%, what is the Total Expected Yield?

Problem 6

Assume a particular function in a $65nm$ process being used today requires a die area of $0.5cm^2$ and that it is fabricated on $300mm$ wafers. Predictions suggest that in a few years, high-end processes will have $7nm$ feature sizes on $450mm$ wafers. Assuming the circuit schematic does not change but the transistor sizes scale with feature size, how large will the die area be on the new, $7nm$ process? How many will you be able to fit on the $450mm$ wafer?

Problem 7

Determine the soft yield of a device that has a current bias requirement of 3mA if the current bias has a Gaussian distribution with a standard deviation of 1.25mA and a mean of 0A. What changes if the mean is 0.1mA?

Problem 8

Given two z-values of –1.25 and 1.25, find the probability of the random variable being within these two values.

Problem 9

What is Six-Sigma and what are some of the problems associated with it in semiconductor manufacturing?

Problem 10

What was most used before BJT and MOS devices were invented? Why did we stop using it?

Problem 11

A precision op amp has a max V_{os} of 10 µV. The average op amp has a V_{os} of 0V. What standard deviation is needed to have a 90% yield? What would the standard deviation be for a six-sigma process?

Problem 12

The cost per good die is $5 and the wafer is a 45cm diameter wafer which costs $3000 per wafer. The die size is $2cm^2$. What is the yield of the die?