Problem Set 2

Problem 2.11

\[ A = (1.4 \text{ cm})^2 = 1.96 \text{ cm}^2 \]

1. 6-inch wafer

\[ N = \frac{\pi (d - \sqrt{A})^2}{4 \times 1.6} (15.24 - 1.4)^2 \approx 76 \]

<table>
<thead>
<tr>
<th>Year</th>
<th>( p_D )</th>
<th>( Y )</th>
<th>( N_G )</th>
<th>Wafer cost</th>
<th>Effective die cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.5</td>
<td>.053</td>
<td>4</td>
<td>$5000</td>
<td>$1250</td>
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<tr>
<td>2</td>
<td>1.325</td>
<td>.074</td>
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<td>$925</td>
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<tr>
<td>3</td>
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<td>7</td>
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<td>$607</td>
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<tr>
<td>4</td>
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<td>.148</td>
<td>11</td>
<td>$3875</td>
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<td>5</td>
<td>.8</td>
<td>.21</td>
<td>16</td>
<td>$3500</td>
<td>$218.70</td>
</tr>
</tbody>
</table>

2. 8-inch wafer

\[ N = \frac{\pi (d - \sqrt{A})^2}{4 \times 1.6} (20.32 - 1.4)^2 \approx 143 \]

<table>
<thead>
<tr>
<th>Year</th>
<th>( p_D )</th>
<th>( Y )</th>
<th>( N_G )</th>
<th>Wafer cost</th>
<th>Effective die cost</th>
</tr>
</thead>
<tbody>
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<td>$10000</td>
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<td>.21</td>
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<td>$6500</td>
<td>$216.70</td>
</tr>
</tbody>
</table>

It is more effective to use an 8-inch wafer.

Problem 2.12

\[ A = -\frac{\ln(\text{yield})}{\rho_D} = -\frac{\ln(1)}{1} = 2.3 \text{ cm}^2 \]

20% of this area is reserved for pads, etc., so we have left = 1.84 cm²

10% of this area is reserved for sense amps, etc., so we have left = 1.66 cm²

\[ f = 1 \mu\text{m} = 2 \lambda \]

Cell size = 135 \( \lambda \)^2 = 33.75 \( \mu\text{m} \)^2

Capacity = \( \frac{1.98 \times 10^3}{33.75 \times 10^{-6}} \) = 4.919 \times 10^6 bits

Of this, we can only use 4 Mb = 2^22 = 4,194,304 bits

New \( A = 2.3 \text{ cm}^2 \times \frac{4194304}{4915406} \) = 1.96 cm²

New Yield = \( e^{-1 \times 1.96} = 14 \% \)

Problem 2.14

\[ A = 2.3 \text{ cm}^2 \]

Yield (5 defects/cm²) = \( \exp -\rho_D \times A = \exp -5 \times 2.3 = 31.7\% \)

Yield (1 defects/cm²) = \( \exp -\rho_D \times A = \exp -1 \times 2.3 = 10.6\% \)

Die (15 cm) = \( \frac{\pi}{4 \times 1.6} (d - \sqrt{A})^2 = \frac{\pi}{4 \times 23} \times (15 - 1.52)^2 = 62 \)

Die (20 cm) = \( \frac{\pi}{4 \times 23} (d - \sqrt{A})^2 = \frac{\pi}{4 \times 23} \times (20 - 1.52)^2 = 116 \)
\[ N_G(d = 15, \rho_D = .5) = 62 \times .317 = 19.7, \text{ cost/good die} = \frac{\$600}{62} = \$254 \]
\[ N_G(d = 15, \rho_D = 1) = 62 \times 1.00 = 6.2, \text{ cost/good die} = \frac{\$800}{62} = \$806 \]
\[ N_G(d = 20, \rho_D = .5) = 116 \times .317 = 35.3, \text{ cost/good die} = \frac{\$400}{35.3} = \$11.4 \]
\[ N_G(d = 20, \rho_D = 1) = 116 \times 1.00 = 11.6, \text{ cost/good die} = \frac{\$600}{11.6} = \$600 \]

For either defect density, the larger wafer is more cost effective for the given die size and wafer costs.

**Problem 2.X**

\[ T = T_f + T_c \]

\[ T = K_f/A_f + (K_c/A_c)^5 = T_c + T_f \]

\[ A = A_f + A_c \]

\[ T = K_f/A - A_c + (K_c/A_c)^5 \]

\[ dT/dA_c = (K_f(A - A_c)^{-2}) + (K_c^5) * (\cdot 5) * A_c^3/2 \]

Set \( dT/dA_c = 0 \)

\[ K_f(A - A_c)^{-2} = (\cdot 5) * K_c^5 * A_c^3/2 \]

\[ K_f/(A - A_c)^2 = K_c^5/2 * A_c^{3/2} \]

Our first solution for \( A_c \) will be \( 2K_f * A_c^{3/2} = K_c^{5} * (A - A_c)^2 \).

Substitute \( A_c = A - A_f \). Our second solution for \( A_f \) will be \( 2K_f * (A - A_f)^{3/2} = K_c^{5} * A_f^2 \).