Problem 1:

Area of one transistor = \(10 \text{ nm} \times 10 \text{ nm} \times 10 = 1000 \text{ nm}^2\)

Diameter of wafer = \(3.048 \times 10^8 \text{ nm}\)

Area of wafer = \(\left(\frac{3.048 \times 10^8}{2}\right)^2 \times \pi = 7.297 \times 10^{16} \text{ nm}\)

Number of dies = \(\frac{7.298 \times 10^{16} \text{ nm}^2}{5000 \times 1000 \text{ nm}^2} = 1.459 \times 10^{10} \text{ dies/wafer}\)

Problem 2:

The cost per die = \(\frac{\$3500}{1.459 \times 10^{10}} = \$2.398 \times 10^{-7} \text{ die}\)

Problem 3

Assuming that a circular ink drop diameter is 100 um:

\[\text{Area} = \left(\frac{100 \times 10^{-6}}{2}\right)^2 \times \pi = 7.854 \times 10^9 \text{ nm}^2\]

Number of transistors = \(\frac{7.854 \times 10^9 \text{ nm}^2}{1000 \text{ nm}^2} = 7.854 \times 10^6\)

Problem 4:

Some can be turned off when not needed. Lower frequency means less power consumed by parasitics.

Problem 5:

Feature size of 10 nm process = 10 nm

Diameter of a silicon atom = 210 pm = 0.210 nm

\[\frac{10 \text{ nm}}{0.210 \text{ nm}} = 47.62 \text{ times larger.}\]

Diameter of a human hair = 100 um = 100,000 nm

\[\frac{10 \text{ nm}}{100,000 \text{ nm}} = \frac{1}{1000} \text{ the diameter of a human hair.}\]

Problem 6

Intel: \$55.35 Billion

Saudi Arameo: \$311 Billion

Nestle \$88.8 Billion
Problem 7:

a) Feature size = 14nm
b) Die area = 82 mm²
c) Transistor area = \( \frac{82 \text{ mm}^2}{1,400,000,000} = 58.572 \times 10^3 \text{ nm}^2 \)
d) Active Area = \( 14 \text{ nm} \times 14 \text{ nm} = 196 \text{ nm}^2 \)
e) \( \frac{\text{Active Area}}{\text{Average Area}} = \frac{196 \text{ nm}}{58.572 \text{ nm}} = 0.003345 = 0.335\% \text{ of the average area is active area} \)

This can also be read as the average area is 298.8 times the active area.

Problem 8:

a) For Core Intel i7 3930k \( P = 123.69W \)
   For gold wire \( \rho = 1.16 \Omega/\text{inch} \)
   Current at 1.2V: \( I = \frac{P}{V} = \frac{123.69W}{1.2V} = 103A \)

b) \( R = \rho \times L = 1.16\Omega \times \frac{1}{2} = 0.58\Omega \)
   \( V = I \times R = 59.78V \)

c) Power Dissipated: \( P = I^2 \times R = 103^2 \times 0.58 = 6153W \)

d) Fusing Current: 0.6~0.7 A
   Actual Current: 0.06~0.07 A
   Number of wires: \( \frac{103}{.06} \sim \frac{103}{.07} = 1471~1717 \text{ gold wired} \)

Problem 9:

<table>
<thead>
<tr>
<th>Type</th>
<th>Storage Density (Bit/cm²)</th>
<th>Cost of Storage ($/bit)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CD</td>
<td>( 10^7 )</td>
<td>( 10^{-11} )</td>
</tr>
<tr>
<td>DVD</td>
<td>( 10^8 )</td>
<td>( 10^{-12} )</td>
</tr>
<tr>
<td>Blue Ray</td>
<td>( 10^9 )</td>
<td>( 10^{-12} )</td>
</tr>
<tr>
<td>Hard Disk</td>
<td>( 10^{10} )</td>
<td>( 10^{-12} )</td>
</tr>
<tr>
<td>SRAM</td>
<td>( 10^7 )</td>
<td>( 10^{-6} )</td>
</tr>
<tr>
<td>DRAM</td>
<td>( 10^9 )</td>
<td>( 10^{-9} )</td>
</tr>
<tr>
<td>FLASH</td>
<td>( 10^{10} )</td>
<td>( 10^{-10} )</td>
</tr>
</tbody>
</table>

\( \text{Ratio} = \frac{10^{-6}}{10^{-12}} = 10^6 \)

Problem 11:

Number of full time engineers = \( \frac{\$500 \times 1 \times 1000000000 \times \$60000}{\$60000} = 8.33 \times 10^5 \text{ engineers} \)
Problem 12:

Area of Skylane Chip = 82 mm²

a) Number of Skylane Chips/wafer = \( \frac{\left(\frac{450 \text{ mm}}{2}\right)^2 \pi}{82 \text{ mm}^2} \) = 1939

b) Cost = \( \frac{\$2500}{1940 \times 0.9} \) = $1.43/chip