1.2 Solution
[18 pt, each answer 2 pt. If the answer is wrong but the reason is fine, will get 1 pt.]

a. Performance via Pipelining
b. Dependability via Redundancy
c. Performance via Prediction
d. Make common case faster
e. Hierarchy of Memories
f. Performance via Parallelism
g. Design for Moore’s Law
h. Use Abstraction to Simplify Design

1.8 The Pentium 4 Prescott processor, released in 2004, had a clock rate of 3.6 GHz and voltage of 1.25 V. Assume that, on average, it consumed 10 W of static power and 90 W of dynamic power.

The Core i5 Ivy Bridge, released in 2012, had a clock rate of 3.4 GHz and voltage of 0.9 V. Assume that, on average, it consumed 30 W of static power and 40 W of dynamic power.

1.8.1 [5] <§1.7> For each processor find the average capacitive loads.

1.8.2 [5] <§1.7> Find the percentage of the total dissipated power comprised by static power and the ratio of static power to dynamic power for each technology.

1.8.3 [15] <§1.7> If the total dissipated power is to be reduced by 10%, how much should the voltage be reduced to maintain the same leakage current?

Note: Do not use unit.

Dynamic Power = \( \frac{1}{2} \times C \times V^2 \times F \), Static Power = \( 1 \times V \).

Solution 1.8 [42 pt]

1.8.1 [14 pt]
Dynamic Power (DP) = \( \frac{1}{2} \times C \times V^2 \times F \rightarrow C = \frac{2 \times DP}{V^2 \times F} \)

Pentium 4 \( \rightarrow \) \( C = \frac{2 \times 10^{-12}}{2.9 \times 3.5 \times 10^9} \) = 3.2 \times 10^{-9} \( \text{F} \) [7pt]

Core i5 Ivy Bridge \( \rightarrow \) \( C = \frac{2 \times 10^{-12}}{2.9 \times 3.5 \times 10^9} \) = 2.9 \times 10^{-9} \( \text{F} \) [7pt]

- No unit is ok. [1.8.1]

1.8.2 [14 pt]
Total dissipated power comprised by static = \( \frac{\text{Power}_{\text{static}}}{\text{Power}_{\text{static}} + \text{Power}_{\text{dynamic}}} \)

Pentium 4 \( \rightarrow \) \( \frac{\text{Power}_{\text{static}}}{\text{Power}_{\text{static}} + \text{Power}_{\text{dynamic}}} = \frac{10}{10 + 90} = 10\% \) [3.5pt]

Core i5 Ivy Bridge \( \rightarrow \) \( \frac{\text{Power}_{\text{static}}}{\text{Power}_{\text{static}} + \text{Power}_{\text{dynamic}}} = \frac{30}{30 + 40} = 42.9\% \) [3.5pt]

The ratio of static power to dynamic power = \( \frac{\text{Power}_{\text{static}}}{\text{Power}_{\text{dynamic}}} \)

Pentium 4 \( \rightarrow \) \( \frac{\text{Power}_{\text{static}}}{\text{Power}_{\text{dynamic}}} = \frac{10}{90} = 11\% \) [3.5pt]

Core i5 Ivy Bridge \( \rightarrow \) \( \frac{\text{Power}_{\text{static}}}{\text{Power}_{\text{dynamic}}} = \frac{30}{40} = 75\% \) [3.5pt]
1.8.3 [14 pt] 

\[
\frac{\text{New Power}_{\text{static}} + \text{New Power}_{\text{dynamic}}}{\text{Old Power}_{\text{static}} + \text{Old Power}_{\text{dynamic}}} = 0.9 \quad \text{solve the equation}
\]

Pentium 4 → \( \frac{\text{New Power}_{\text{static}} + \text{New Power}_{\text{dynamic}}}{\text{Old Power}_{\text{static}} + \text{Old Power}_{\text{dynamic}}} = 0.9 \rightarrow V_{\text{new}} = 1.18 \rightarrow \frac{125}{1.18} = 1.06 \%
\)

Core i5 Ivy Bridge → \( \frac{\text{New Power}_{\text{static}} + \text{New Power}_{\text{dynamic}}}{\text{Old Power}_{\text{static}} + \text{Old Power}_{\text{dynamic}}} = 0.9 \rightarrow V_{\text{new}} = 0.84 \rightarrow \frac{0.9 - 0.84}{0.9} = 6.7\%
\)

Or \( V_{\text{new}} = X \times V_{\text{old}} \rightarrow \frac{\text{New Power}_{\text{static}} + \text{New Power}_{\text{dynamic}}}{\text{Old Power}_{\text{static}} + \text{Old Power}_{\text{dynamic}}} = 0.9 \rightarrow \frac{X \times \text{Old Power}_{\text{static}} + \text{Old Power}_{\text{dynamic}}}{\text{Old Power}_{\text{static}} + \text{Old Power}_{\text{dynamic}}} = 0.9 \rightarrow \text{solve the equation}
\)

Pentium 4 → \( \frac{X \times (30 + 10)}{30 + 40} = 0.9 \rightarrow X = 0.946 \rightarrow 5.4\%
\)

Core i5 Ivy Bridge → \( \frac{X \times (30 + 40)}{30 + 40} = 0.9 \rightarrow X = 0.935 \rightarrow \frac{0.9 - 0.84}{0.9} = 6.5\%
\)

- Apply different dynamic power equation with 1.8.1. - [1.8.3]
- Consider only static power -10 [1.8.3]
- No reduced percentage -1 [1.8.3] & & Calculation error -1 [1.8.3]

1.11 Solution

1.11.1
Ans: 0.94

1.11.2
Ans: 12.86

1.11.4
Ans: 866.25s total or increase 15.5% or 116.25s

1.11.6
Ans: 1.3788

1.11.7
Clock rate: 4GHz/3GHz = 1.25
CPI: 1.38/0.94 = 1.47
They are different [5pt] because, although the number of instructions has been reduced by 15%, the cpu time has been reduced by a lower percentage. [2pt]

1.11.8
Ans: cpu time reduction 6.7%

1.11.9
\[
\frac{\text{Time} \times \text{Clock rate}}{\text{CPI}} = \text{No. of Instruction.}
\]
\[
\frac{0.9 \times 960 \times 10^{-9} + 10^{5}}{1.81} = 2146.5
\]

1.11.11
Clockrate = \frac{\text{No. of Instruction} \times \text{CPI}}{\text{CPU time}}
\[ \text{clockrate}_{\text{new}} = \frac{0.85}{0.8} \times \text{clockrate}_{\text{old}} = 3.1875 \]

**Note:**
- 每題五分，1.11.7 的原因 2 分，合計 42 分
- 算式對，答案錯，扣兩分
- 1.11.11 若帶 4GHZ 扣一分