Problem Set 1

1 a) The amended version of Moore's law applies to modern-day chip designs.
False, as transistor density no longer increases at the same rate.

b) The MTBF is defined as the difference between MTTF + MTTR.
False, it is defined as the sum of MTTF + MTTR.

c) The MIPS architecture is an example of CISC.
False the MIPS architecture is an example of RISC.

d) Temporal locality states that recently used items are less likely to be accessed soon.
False, they are more likely to be accessed again soon.

e) The data transfer between cache and memory takes place in the form of a block.
True

B

Problem Set 1 (cont.)

2 Book exercises 1.8, 1.9, 1.11, 1.15, 1.16

1.8) a) You save 50% of the energy in comparison by going twice as fast.

b) $E_{dyn} \propto CV^2$ if voltage is cut in half

$E = \frac{1}{2} \cdot C \cdot V^2$ $\quad \frac{CV_2^2}{CV_1^2}$ $\quad V_2 = \frac{1}{2} V_1$

$\Rightarrow \frac{\left(\frac{V_1^2}{4}\right)}{V_1^2} \Rightarrow \frac{V_1^2}{4 V_1^2} \Rightarrow \frac{1}{4}$ the energy

$\therefore$ 75% less or 1/4 the original energy

1.9) a) 60% since those are entirely turned off.

b) $40\% + (60\% \cdot 20\%) \Rightarrow 0.4 + (0.6 \cdot 0.2)$

$\Rightarrow 0.52$ or 52% of original

or 48% power saved.

c) Power = Energy $\cdot$ Freq $\quad P_{new} = \frac{1}{2} \cdot C \cdot (0.8 \cdot V_1)^2 \cdot (0.6 \cdot F_{req})$

$\Rightarrow \frac{P_{new}}{P_{old}} = \frac{(0.8)^2 \cdot 0.6}{1}$ $\quad P_{old} = \frac{1}{2} C \cdot V_1^2 \cdot F_{req}$

$\Rightarrow \Rightarrow 0.384$ or $\approx$ 38.4% of original energy or 61.6% of power saved

d) $0.4 + (0.3 \cdot 0.2) = 0.46$

46% of original power or 54% power saved

$\Rightarrow$

Problem Set 1 (cont)

2 1.11) a) $\frac{35 \text{ days per failure}}{10000 \text{ computers}} = 0.0035 \cdot 3333$ computers failing

$$\boxed{\Rightarrow 11.6655 \text{ days for MTTF for the system}}$$

b) Assuming we upgrade all units, using part as example, for $10 Million it would change the system MTTF to 23.331 days. So doubling the individual MTTF more than doubles the system MTTF. For companies like Amazon or eBay, system failure can cost millions in revenue loss from time lost and cost of time and cost of repair itself. So it would likely be a good business decision for these types of company

c) Downtime per hour = 90000

$$90000 = (Q + Q + Q + 2Q)/4$$

$$\Rightarrow 90000 = \frac{5}{4} Q \Rightarrow Q (\text{Avg cost per quarter}) = 72000$$

$$Q_4 = 2Q \Rightarrow Q_4 = 144000$$

Avg downtime cost normally
$\Rightarrow$ \$72,000/hour

Avg downtime cost for Q4
$\Rightarrow$ \$144,000/hour

$\Rightarrow$

Problem Set 1 (cont.)

2 1.15) a) $\frac{1}{(1-0.5)+\frac{0.5}{22}} \Rightarrow \boxed{1.913 = \text{Speedup}_{\text{overall}}}$
for A

b) $\frac{1}{(1-0.9)+\frac{0.9}{22}} \Rightarrow \boxed{7.097 = \text{Speedup}_{\text{overall}}}$
for D

c) $\frac{1}{(1-0.5)+\frac{0.5}{22\cdot 0.41}} \Rightarrow \boxed{1.8004 = \text{Speedup}_{\text{overall}} \text{ for A on 41\% of resources}}$

d) $1.8004 + \left(\frac{1}{(1-0.8)+\frac{0.8}{22\cdot 0.27}}\right) + \left(\frac{1}{(1-0.6)+\frac{0.6}{22\cdot 0.18}}\right) + \left(\frac{1}{(1-0.9)+\frac{0.9}{22\cdot 0.14}}\right)$

$\Rightarrow \boxed{\text{Speedup}_{\text{overall}} = 9.15118}$ for the processor if all applications have their percentage of resources + are parallelized across those resources.

e)

$A \Rightarrow \frac{1}{1.8004} \cdot 0.41 = 0.2277 \Rightarrow 22.77\%$

$B \Rightarrow \frac{1}{2.98793} \cdot 0.27 = 0.0904 \Rightarrow 9.04\%$

$C \Rightarrow \frac{1}{1.81319} \cdot 0.18 = 0.0993 \Rightarrow 9.93\%$

$D \Rightarrow \frac{1}{2.54967} \cdot 0.14 = 0.0549 \Rightarrow 5.49\%$

Problem Set 1 (cont)

2 1.16) a) $\text{Speedup} = \dfrac{1}{(1-0.8)+\frac{0.8}{N}}$

$\Rightarrow \boxed{\text{Speedup} = \dfrac{1}{0.2+\frac{0.8}{N}}}$

b) 8 added processors each 0.5% of original exec time

$\Rightarrow \text{Speedup} = \dfrac{1}{(1-0.8)+\underbrace{(8 \cdot 0.005)}+\left(\frac{0.8}{8}\right)}$

$\Rightarrow \boxed{\text{Speedup} = 2.94}$

c) Increase by 0.5% comm overhead when # of processors doubles.
$1 \to 8$ is doubling 3 times

$\text{Speedup} = \dfrac{1}{(1-0.8)+(3 \cdot 0.005)+\left(\frac{0.8}{8}\right)}$

$\Rightarrow \boxed{\text{Speedup} = 3.17}$

d) Doubling is equal to $\log_2 N$ for N processors

$\boxed{\Rightarrow \text{Speedup} = \dfrac{1}{(1-0.8)+(\log_2(N) \cdot 0.005)+\left(\frac{0.8}{N}\right)}}$

$\Rightarrow$

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Problem Set # 1

2 1.16) e) It would be where the derivative of the following equation equals 0

$\Rightarrow$ Speedup $= f(N) = \frac{1}{(1-P\%)+(\log_2(N)\cdot 0.005)+\left(\frac{P\%}{N}\right)}$

$$\Rightarrow \boxed{\frac{d}{dN}\left(\frac{1}{(1-P\%)+(\log_2(N)\cdot 0.005)+\left(\frac{P\%}{N}\right)}\right)=0}$$