1223 = Val

H1 Arch

1. a.) False, increasing performace usually decreases energy efficiency not the other way around

b.) True, a system needs all of its parts to function ~~probably~~ properly, so the failure point will always be the weakest link in the chain. This is why designing redundancies are good.

c.) False, Amdahl's Law is very useful for finding latency and/or bottleneck points. It can also be used to show speedup in, not only serial programs, but parallel ones as well.

d.) False, Clock speed is only one aspect of performance. There are many other factors you must take into account, in order to minimize exec time

e.) True, you can have 1 million cores available but if the software is serial, it won't make much of a difference

2. 1.8) a) $E = 1/2\ \text{Capacitive Load} \times V^2 = \frac{1}{2} C V^2$

$E = E_{exec} + E_{idle}$, since computation takes 1/2 the amount of time to run, the energy would be 50%

$$\frac{E}{2} = E_{exec} = \boxed{50\%}$$

b.) With Energy, f doesn't matter, so $E = \frac{CV^2}{2}$

$E_{new} = \frac{C\left(\frac{V}{2}\right)^2}{2}$ ⟶ cont on next page

b.) Cont $\frac{E}{E_{new}} = \frac{CV^2}{2} \cdot \frac{2}{C(V/2)^2} = \frac{V^2}{\frac{V^2}{4}} = V^2 \cdot \frac{4}{V^2} = 4$

$E_{new} = \frac{E}{4}$, Saved $= E - E_{new} = E - \frac{E}{4} = E(1 - \frac{1}{4}) \Rightarrow$

Saved $= \frac{3}{4}E = \boxed{.75E \text{ or } 75\% \text{ Less energy}}$

1.9 PC = Power Consumption, S = number of servers
M = max power consumption, PS = power savings

a.) $PC = .9(M)(S)$

$PC_{new} = PC - .9(M)(.6S) = .9(MS) - .54(MS) = .36MS$

$PS = 1 - \frac{PC_{new}}{PC} = 1 - \frac{.36MS}{.9MS} = 1 - .4 = .6 = \boxed{60\%}$

1.9 PC = Power Consumption, M = max PC, S = # servers,
PS = Power Savings

a.) $PC = .9MS$, $PC_{new} = .9(M)(1-.6)S = .36MS$

$$PS = 1 - \frac{PC_{new}}{PC} = 1 - \frac{.36}{.9} = 1 - .4 = .6 = \boxed{60\%}$$

b.) $PC = .9MS$

$$PC_{new} = .9(M).4(S) + .2(M).6(S) = .36MS + .12MS = .48MS$$

$$PS = 1 - \frac{PC_{new}}{PC} = 1 - \frac{.48MS}{.9MS} = 1 - .53 \boxed{\approx .47}$$

c.) $PC = \frac{CV^2f}{2} = \frac{Ef}{2}$

$$PC_{new} = \frac{C((1-.2)V)^2((1-.4)f)}{2} = \frac{C(.8V)^2(.6f)}{2} = \frac{.384CV^2f}{2} = \frac{.384Ef}{2}$$

$$PS = \frac{PC - PC_n}{PC} = 1 - \frac{.384Ef/2}{Ef/2} = 1 - .384 = \boxed{.616 \approx 62\%}$$

d.) $PC_{new} = .9(M)(1-.6)(S) + .2(M).3(S) = .36MS + .06MS$

$$= .42MS$$

$$PS = \frac{PC - PC_n}{PC} = \frac{.9MS - .42MS}{.9MS} = 1 - \frac{.42}{.9} = 1 - .467 \approx \boxed{.53 = 53\%}$$

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$$\text{Amdahl} = \frac{\text{Exec old}}{\text{Exec new}}$$

1.12 b.) $2 = \dfrac{\text{Exec old}}{\text{Exec new}} = \dfrac{1}{(1-F) + \dfrac{F}{20}} \Rightarrow$

$$(1-F) + \frac{F}{20} = \frac{1}{2} \Rightarrow 20 - 20F + F = 10$$

$$\Rightarrow 10 = 20F - F = 19F, \quad \boxed{F = \frac{10}{19} \approx 53\%}$$

~~c.) ExecTimenew~~ $\cancel{= E_o\left(1 - \frac{10}{19}\right) + \frac{\frac{10}{19}}{20}}$

$$\cancel{E_n = \frac{E_o}{20}} \qquad \cancel{\frac{E_o}{20} = E_o\left(\frac{9}{19} + \frac{10}{19(20)}\right)}$$

$$\cancel{E_o = 20E_o\left(\frac{9}{19}\right) + 20E_o\left(\frac{10}{19(20)}\right) =}$$

$$\cancel{0 = \frac{180E_o}{19} + \frac{10E_o}{19} - E_o = \frac{190E_o}{19} - E_o = 10E_o - E_o}$$

$$\cancel{= 9E_o = 0}$$

$$\cancel{E_o = \frac{0}{9}}$$

c.) $S_2 = \dfrac{1}{(1-.9(1/2)) + \dfrac{.9(1/2)}{2}} = \dfrac{1}{.55 + .225} = \dfrac{1}{.775}$

$$\boxed{\approx 1.29}$$

c.) $S_4 = \frac{1}{.55 + \frac{.45}{4}} = \frac{1}{.55 + .1125} = \frac{1}{.6625} =$

$\boxed{\approx 1.51}$

1.14 a.) $S = \frac{1}{(1-.2) + \frac{.2}{2}} = \frac{1}{.8 + \frac{1}{10}} = \frac{1}{.9} \approx \boxed{1.11}$

b.) $S = \frac{1}{\cancel{(1-.1) + \frac{.1}{2/3}}} =$

$(1-.1-.2) + \frac{.1}{2/3} + \frac{.2}{2}$

$\frac{1}{.7 + .1\ \frac{.3}{2}} = \frac{1}{.95} \boxed{\approx 1.05}$

S = Speedup from b.)

c.) $F\% = \frac{.2}{2} S = \frac{.2}{2} \times 1.05 = \boxed{0.105} = \boxed{10.5\%}$

$Cache\% = \frac{.1}{2/3} S = \frac{.3}{2} \times 1.05 = \boxed{0.1575} = \boxed{15.75\%}$

1.16 a.) $S = \frac{1}{(1-.8) + \frac{.8}{N}} = \frac{1}{.2 + \frac{.8}{N}}$

$\cancel{\frac{N.2}{N} + \frac{.8}{N} = \frac{.2N + .8}{N} = \frac{N}{.2N + .8}}$

$\frac{1}{(1-.8) + \frac{.8}{N}} = \frac{1}{.2 + \frac{.8}{N}}$

$.2\left(1 + \frac{.4}{N}\right) = \frac{1}{(1-4/5) + \frac{4}{5N}} = \frac{1}{\frac{1}{5} + \frac{4}{5N}}$

$= \frac{1}{\frac{N}{5N} + \frac{4}{5N}} = \frac{N+4}{5N} = \boxed{\frac{5N}{N+4}}$

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1.16 b.) $\cancel{\frac{5N}{N+4} + .005N}$

b.) $\cancel{\frac{(.8)}{8+4} + \frac{.40}{12}}$

$$\frac{1}{(1-4/5)+\frac{4/5}{8}+.005(8)} = \frac{1}{\frac{1}{5}+\frac{4}{40}+.04}$$

$$= \frac{1}{.2+.1+.04} = \frac{1}{.34} \boxed{\approx 2.94}$$