2. Computer Performance

(25pts) AMD tries to improve their CPU. They decide to use the 14nm process technology to manufacture their new CPU. But Intel, as a rival, transfers their manufacturing to 7nm process.

If both processors would be manufactured with the same process technology, AMD would have **1.2x** better speed performance for a specific testbench program, for which the instruction distribution is given in the below table.

A CPU manufactured by **7nm** process is ~~3x~~ 1.8x faster than the one manufactured by **14nm** process.

You are a CPU designer working in AMD and try to remove the performance gap with Intel. You will change the hardware to implement a faster addition instruction.

How many times faster the new addition instruction must be to have the same speed with Intel for this testbench program? Show your computations and explain.

Instruction type	Instruction distribution
addition	60%
jump/branch	10%
lw/sw	12%
logic	18%

AMD Runtime = d

Intel Runtime = 1.2d

$\Rightarrow$ Intel Runtime 7nm = $\frac{1.2\,d}{1.8}$

$= \frac{2}{3}\,d$ (7)

Previously assume that AMD Runtime = 100 (7)

Now it should be = $\frac{2}{3}\,100 = \frac{200}{3} \sim 66.67$

As other instr. will not be affected

j/b + lw/sw + logic = 40

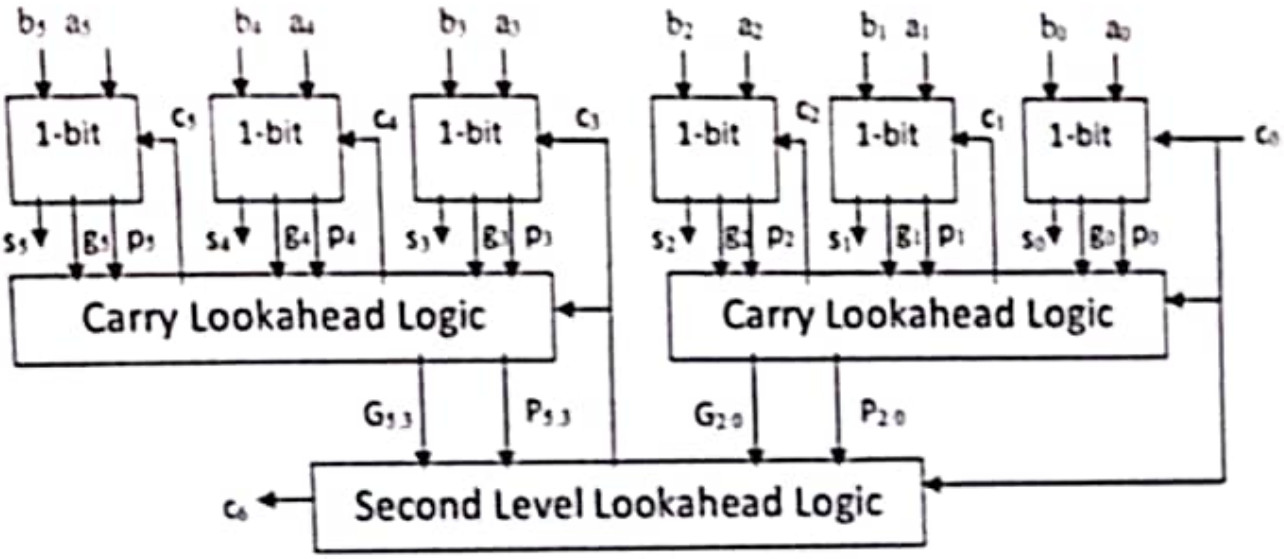
For add we have 66.67 − 40 = 26.67 $\sim \frac{80}{3}$

Previously add was 60 (11)

$\Rightarrow$ add must be $\frac{360}{480/3} = \frac{9}{4} = 2.25\times$ Faster than before.

3. Computer Arithmetic

The following is the 6-bit carry look-ahead adder:



a. (10pts) Write the boolean formulas for group generate and propagate signals ($G_{2:0}$, $G_{5:3}$, $P_{2:0}$, and $P_{5:3}$) in terms of p_i's and g_i's.

$$G_{2:0} = g_2 + g_1 p_2 + g_0 p_1 p_2$$

$$P_{2:0} = p_2 p_1 p_0$$

$$G_{5:3} = g_5 + g_4 p_5 + g_3 p_4 p_5$$

$$P_{5:3} = p_5 p_4 p_3$$