Question: What is the speedup of Machine A over Machine B?

Note:

- Ideal CPI = 1 for both.
- Loads are 40% of instructions executed.
- Machine A: Dual ported memory ("Harvard Architecture") without the structural hazard.
- Machine B: Single ported memory, but its pipelined implementation has 1.05 times faster clock rate with the hazard.

Answer:

The general speedup equation is given by:

$$\text{Speedup} = \left(\frac{\text{Pipeline Depth}}{1 + \text{Pipeline stall CPI}}\right) \times \left(\frac{\text{CycleTime(unpipelined)}}{\text{CycleTime(pipelined)}}\right)$$

Speedup of Machine A:

$$\frac{\text{Pipeline Depth}}{1+0} \times \left(\frac{1}{1}\right) = \frac{\text{Pipeline Depth}}{1} \times 1 = \text{Pipeline Depth}$$

Speedup of Machine B:

$$\frac{\text{Pipeline Depth}}{1+0.4} \times 1.05 = \frac{\text{Pipeline Depth}}{1.4} \times 1.05 = 0.75 \times \text{Pipeline Depth}$$

Speedup of A over B:

$$\frac{\text{Speedup(A)}}{\text{Speedup(B)}} = \frac{\text{Pipeline Depth}}{0.75 \times \text{Pipeline Depth}} = 1.33$$

Conclusion: Machine A is faster by 33% or 1.33 times faster.