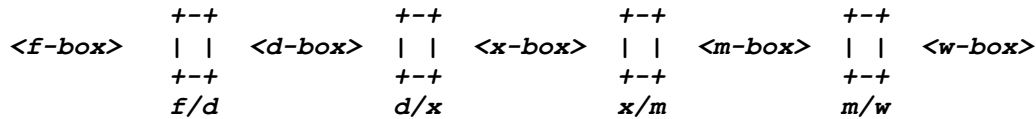


## Pipeline Practice Exercises

Consider our instruction-execution pipeline **with forwarding**: Each of the following 6 questions is independent.



- a- When the d-box decodes the instruction 'l.d f6,-24(r2)', it sends the following 3 information to the x-box: add signal, immediate -24, register r2 value.
- b- When the d-box decodes the instruction 'mul.d f6, f2, f4', it sends the following 3 information to the x-box: opcode multiply, value of f2, value of f4. The w-box will receive the following 2 information: result of multiplication, id of f6 for the same instruction.
- c- When the m-box processes the instruction 'l.d f6, -4(r4)', it receives the following information: the address 4-r4, load signal from the x- box and it sends the following information: data from memo address r4-4, id of f6 to the w-box box.
- d- When the pipeline is processing the instruction 's.d f8, 4(r2)', the **m-box** receives 2 different types of values. Indicate type & value for each : memory address 4+r2, data/value at f8.
- e- In the pipeline, the f-box increments the PC for each and every instruction while the d-box modifies the PC only if a branch will be executed.
- f- Consider the following 2 independent sets of instructions:

	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	
add r1, r1, 8	f	d	x	n	w		
l.d f8, 4(r1)		f	d	x	m	w	
	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>
l.d f8, 4(r1)	f	d	x	m	w		
add f6, f8, f4		f	d	s	x	n	w

There is data dependency within each set of instructions; Explain briefly (1-2 sentences) each dependency and how it affects the data flow in the pipeline.

	$+-+$		$+-+$		$+-+$		$+-+$		$+-+$
$\langle f\text{-box} \rangle$	$\begin{array}{c}   \\   \end{array}$	$\langle d\text{-box} \rangle$	$\begin{array}{c}   \\   \end{array}$	$\langle x\text{-box} \rangle$	$\begin{array}{c}   \\   \end{array}$	$\langle m\text{-box} \rangle$	$\begin{array}{c}   \\   \end{array}$	$\langle w\text{-box} \rangle$	
	$+-+$		$+-+$		$+-+$		$+-+$		
	$f/d$		$d/x$		$x/m$		$m/w$		

Assume that the following are the only control signals: <x-box> no-op, add, mult, shift; <m-box> no-op, load, and store; <w-box> no-op, write-back. Consider the following program

```

          1 2 3 4 5 6 7 8 9 0
l.d  f6,-8(r2)  f d x m w
l.d  f8,-16(r3)  f d x m w
mul.d f10,f6,f8      f d   x m w
sll  f10,f10,16      f   d x m w
s.d  f10,24(r4)      f d x m

```

- a) Write down the 4 control signals received by the x-box during cycles 4-7. Ans add noop multiply shift
- b) Write down the 4 control signals received by the m-box during cycles 4-7. Ans load load noop noop
- c) Write down the 4 control signals received by the w-box during cycles 4-7. Ans noop writeback writeback noop
- d) Which box initiates the control signals for other boxes working on the same instruction? d-box