Pipeline Practice Exercises

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

```
        +-+            +-+            +-+            +-+
<f-box> | | <d-box>    | | <x-box>   | | <m-box>   | | <w-box>
        +-+            +-+            +-+            +-+
        f/d            d/x            x/m            m/w
```

a- When the d-box decodes the instruction 'l.d f6,-24(r2)', it sends the following 3 information to the x-box: _____, _____, _____.

b- When the d-box decodes the instruction 'mul.d f6, f2, f4', it sends the following 3 information to the x-box: _____, _____, _____. The w-box will receive the following 2 information: _____, _____ for the same instruction.

c- When the m-box processes the instruction 'l.d f6, -4(r4)', it receives the following information: _____, _____ from the _____ box and it sends the following information: _____, _____ to the _____ 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 : _____, _____.

e- In the pipeline, the _____ increments the PC for each and every instruction while the _____ modifies the PC only if a branch will be executed.

f- Consider the following 2 independent sets of instructions:

	1	2	3	4	5	6
add r1, r1, 8	f	d	x	n	w	
l.d f8, 4(r1)		f	d	x	m	w

	1	2	3	4	5	6	7
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.

```
          +-+                +-+                +-+                +-+
<f-box>   | |    <d-box>     | |    <x-box>     | |    <m-box>     | |    <w-box>
          +-+                +-+                +-+                +-+
          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 _____ _____ _____ _____

b) Write down the 4 control signals received by the m-box during cycles
   4-7. Ans _____ _____ _____ _____

c) Write down the 4 control signals received by the w-box during cycles
   4-7. Ans _____ _____ _____ _____

d) Which box initiates the control signals for other boxes working on
   the same instruction?