**Review Ch.3-4**

**Arithmetic and Datapath**

1. Describe the algorithm that performs the multiplication of two binary integers.
2. Perform the division of 100111 by 100.
3. What is the difference between single and double precision?
4. Use the IEEE 754 standard for the representation of the following numbers:
   1. -35.25
   2. 125.75
5. What is the overflow? What is the underflow? Give an example of overflow and underflow. When does it occur?
6. Perform the addition of these numbers:

1.110001 \* 2-7 + 1.0001 \* 25 + 1.11110 \* 21 =

1. Perform the multiplication of these numbers:

1.110001 \* 2-4 +1.110 \* 21 =

1. (Skip this question) What is the benefit of using the guard and round in floating point arithmetic?
2. What is the job of a multiplexor? What is the value assigned to the data selector of a multiplexor if we want to output the signal carried by the fourth wire entering in input the multiplexor?
3. Consider the simple single-cycle datapath described in your book. How many functional units (or datapath elements if you prefer) are part of the implementation of the datapath?
4. What is the purpose of the Data Memory in the single-cycle implementation?
5. A state element is also called a …………… element.
6. What is an edge-trigger clocking?
7. What is the need for a clock?
8. Describe the path taken by the load instruction in a single-cycle implementation scheme. (answer the same question for all the other types of instructions)
9. Which instructions use the Sign Extend unit in the single-cycle implementation scheme?
10. When is the MemtoReg asserted in a single-cycle implementation scheme? Give the name of an instruction that requires the assertion of the MemtoReg.
11. Explain the purpose of the control unit in a single-cycle implementation scheme.
12. There are two possible 5bit chunks, i.e. [20-16] and [15-11] of the 32 bit instructions that are used to indicate the Write Register. Describe in which case the first is used and in which case the second is used.
13. Why is a multi-cycle implementation scheme introduced?
14. What are the differences of the multi-cycle implementation scheme with respect to the single-cycle implementation scheme?
15. The time to execute a load in a multi-cycle implementation scheme is slower than the time to execute a load in a signle-cycle implementation scheme. Why is that?
16. Trace a store instruction on the multicycle implementation scheme. What are the values of the control signals in each of the cycles?
17. In which stage of the multicycle implementation, the following steps are performed?
    1. the Instruction[25:21]of the instruction is read and given in input to the ALU
    2. the Instruction[20:16]of the instruction is read and given in input to the ALU
    3. the PC and the (sign-extend(Instruction[15-0] << 2) is given in input to an adder;
18. Which is the shortest instruction in a multi-cycle implementation scheme?
19. (Skip this question) Is it possible that the control signal PCWriteCond can be replaced by the PCSource[0] in the multi-cycle implementation scheme. If so, when?
20. What is a “don’t care” symbol and when it is used? This answer is in the book not in the slides.
21. Consider the following code:

Repeat:lw $t1, 0($t2)

subi $t1, $t1, 3

sw $t1, 0($t2)

addi $t3, $t3, 12

bne $zero, $t3, Repeat

and simulate it on a 5-stages pipeline.

1. What types of hazards are available in a pipelined implementation? Describe each type.
2. Consider the following code.
   1. How many cycles will be required to properly execute the following code if NO additional techniques are used to prevent or eliminate stalling? Specify also where each stall occurs.

add $t1, $t2, $t3

subi $t1, $t1, 3

lw $t1, 0($t2)

add $t3, $t3, $t1

bne $zero, $t3, Loop

1. How many cycles will be required to properly execute the previous code if forwarding or code optimization is used to minimize stalling? Show where forwarding, stalling, or instruction permutation occurred.
2. What is forwarding and how is it realized?
3. Can forwarding eliminate any data hazard? Explain.
4. What is dynamic branch prediction and where is it used?
5. How are exception handled?