# Homework 2 2-1 Processor

1. Consider the operation of a machine with the data path of Figure 2-2. Suppose that loading the ALU input registers take 5 nsec, running the ALU takes 10 nsec, and storing the result back in the register scratchpad takes 5 nsec. What is the maximum number of MIPS this machine is capable of in the absence of pipelining?  
  
The total time for one cycle is 20nsec (input registers 5nsec, running the ALU 10nsec, storing result back in the register 5nsec). Since a nanosecond is 1 billionth of a second, we would divide 1 billion by 20 to get 50 million. Therefore, the maximum number of MIPS this machine is capable of without pipelining is 50.

2. What is the purpose of step 2 (modify the PC) in the fetch-decode-execute cycle? What would happen if this step were omitted?  
  
PC must be incremented to move on to the next instruction. If modifying it were omitted, the same initial instruction would be run indefinitely.

3. On computer 1, all instructions take 10 nsec to execute. On computer 2, they all take 5 nsec to execute. Can you say for sure that computer 2 is faster? Discuss.  
  
We wouldn’t be able to know for sure because we don’t have any information on each individual computer’s architecture. If computer 1 is pipelined and computer 2 is not, computer 1 could very well be significantly faster.

4. To compete with the newly-invented printing press, a certain medieval monastery decided to mass-produce handwritten paperback books by assembling a vast number of scribes in a huge hall. The head monk would then call out the first word of the book to be produced and all the scribes would copy it down. Then the head monk would call out the second word and all the scribes would copy it down. This process was repeated until the entire book had been read aloud and copied. Which of the parallel processor system discussed in this chapter does this system resemble most closely?  
  
This would be similar to SIMD system (single instruction-stream multiple data-stream). All the monks (processors) are running the same sequence of instructions for different types of data. Only one head monk (brain) is needed.

# 2-2: Memory

1. Sociologists can get 3 possible answers to a typical survey question such as "Do you believe in the tooth fairy?", namely, yes, no, and no opinion. With this in mind, the ABC computer company has decided to build a computer to process survey data. This computer has a trinary memory, i.e., each tryte consists of 8 trits, with a trit holding a 0, 1, or 2. How many trits are needed to hold a 6-bit number? Give an expression for the number of trits needed to hold n bits.  
     
   26 = 64. 33 would only be 27, but 34 would be 81 combinations. Therefore, with a base of 3 (a trit), we would need at least 4 trits.
2. A certain computer can be equipped with 1,073,741,824 bytes of memory. Why would a manufacturer choose such a peculiar number, instead of an easy-to-remember number like 1,000,000,000?  
     
   Computers use the binary number system which are powers of 2. 230 is equivalent to 1,073,741,824. Exactly 1,000,000,000 wouldn't be possible as a power of 2.
3. Devise a 7-bit even parity Hamming code which can correct 1-bit error for the digits 0 to 9. Hint: we need 4 data bits (0000 for 0, 0001 for 1, …, 1001 for 9) and 3 check bits.  
     
   The data bits would be 3, 5, 6, and 7. The parity bits would be 1, 2, and 4.  
     
   0: 0000000  
   1: 1101001  
   2: 0101010  
   3: 1000011  
   4: 1001100  
   5: 0100101  
   6: 1100110  
   7: 0001111  
   8: 1110000  
   9: 0011001
4. Devise a code for the digits 0 to 9 whose Hamming distance is 2. Hint: we need 4 data bits (0000 for 0, 0001 for 1, …, 1001 for 9) and 1 check bit.  
     
   0: 0000 0  
   1: 0001 1  
   2: 0010 1  
   3: 0011 0  
   4: 0100 1  
   5: 0101 0  
   6: 0110 0  
   7: 0111 1  
   8: 1000 1  
   9: 1001 0
5. An extended ASCII character is represented by an 8-bit quantity. The associated Hamming code which corrects 1-bit error of each character can then be represented by a string of 12 bits, or 3 hex digits. Encode the following 5-character ASCII text using an even-party Hamming code: Earth. Show your answer as a string of hex digits. Hint: ASCII for 'E' is hex 45, 'a' is 61, 'r' is 72, 't' is 74, 'h' is 68.  
     
   1100 1000 0101  
   1101 1101 0001  
   1101 1111 0010  
   0101 1111 0100  
   0100 1101 1000  
     
   = C85 DD1 DF2 5F4 4D8
6. The following string of hex digits encodes extended ASCII characters in an even-parity Hamming code: 0D3 DD3 0F2 5C1 1C5 CE3. Decode this string (you might have to correct 1-bit error when decoding) and write down the characters that are encoded. Hint: ASCII for 'a' is hex 61, and lowercase letters are consecutive in ASCII.

0000 1101 0011 12th bit error  
 1101 1101 0011 11th bit error  
 0000 1111 0010 7th bit error  
 0101 1100 0001 9th bit error  
 0001 1100 0101 1st bit error  
 1100 1110 0011 no error  
  
 = babies