ESE-2005 Lab 5 Shifters and memory arrays

Exercise

1. Design a shifter that always shifts a 32-bit input left by 2 bits. The input and output are both 32 bits. Explain the design in words and sketch a schematic.

2. The English language has a good deal of redundancy that allows us to reconstruct garbled transmissions. Binary data can also be transmitted in redundant form to allow error correction. For example, the number 0 could be coded as 00000 and the number 1 could be coded as 11111. The value could then be sent over a noisy channel that might flip up to two of the bits. The receiver could reconstruct the original data because a 0 will have at least three of the five received bits as 0's; similarly a 1 will have at least three 1's.

   a) Propose an encoding to send 00, 01, 10, or 11 encoded using five bits of information such that all errors that corrupt one bit of the encoded data can be corrected. Hint: the encodings 00000 and 11111 for 00 and 11, respectively, will not work.
   b) Design a circuit that receives your five-bit encoded data and decodes it to 00, 01, 10, or 11, even if one bit of the transmitted data has been changed.
   c) Suppose you wanted to change to an alternative 5-bit encoding. How might you implement your design to make it easy to change the encoding without having to use different hardware?

3. The extraterrestrial life project team has just discovered aliens living on the bottom of Mono Lake. They need to construct a circuit to classify the aliens by potential planet of origin based on measured features available from the NASA probe: greenness, brownness, sliminess, and ugliness. Careful consultation with xenobiologists leads to the following conclusions:

   1. If the alien is green and slimy or ugly, brown, and slimy, it might be from Mars.
   2. If the critter is ugly, brown, and slimy, or green and neither ugly nor slimy, it might be from Venus.
   3. If the beastie is brown and neither ugly nor slimy or is green and slimy, it might be from Jupiter.

   Note that this is an inexact science; for example, a life form which is mottled green and brown and is slimy but not ugly might be from either Mars or Jupiter.
   (a) Program a 4 x 4 x 3 PLA(Programmable logic arrays) to identify the alien. You may use dot notation.
   (b) Program a 16 x 3 ROM to identify the alien. You may use dot notation.