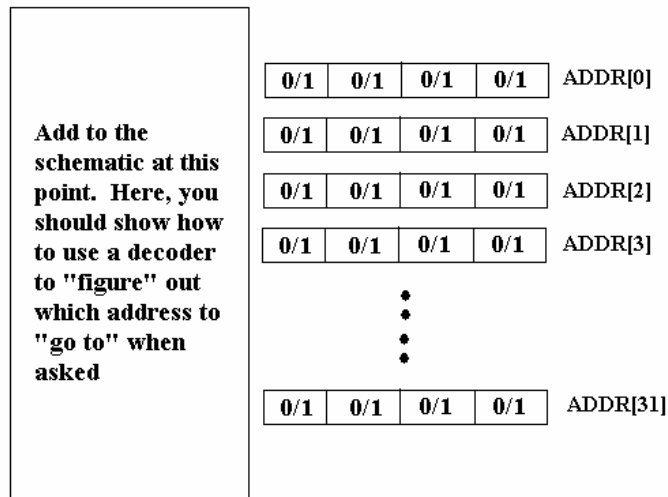


**ECE 370: Digital Systems-Logic Design**  
*Sample Test: Chapter 6-Part 1: Decoders & Encoders*  
Spring 2005

**Decoders**

1. Describe in general how an  $n$  to  $2^n$  binary decoder functions and when it is used?
2. What is the purpose of the enable input to a decoder?
3. Design an active high decoder that detects the presence of the following input sequences. Repeat the design with an active low decoder design. What is the cost of each design, assuming the cost includes inverters?
  - a)  $D_4D_3D_2D_1D_0 = 01001$
  - b)  $D_4D_3D_2D_1D_0 = 00111$
  - c)  $D_4D_3D_2D_1D_0 = 00000$
  - d)  $D_4D_3D_2D_1D_0 = 11110$
  - e)  $D_4D_3D_2D_1D_0 = 11000$
  - f)  $D_4D_3D_2D_1D_0 = 11111$
4. Design a 3-to-8 line binary decoder and show the schematic of your design.
5. Design a 4-to-16 line binary decoder using only 3-to-8 line binary decoders. Show a detailed schematic of your design.
6. Design each set of functions expressed in canonical form using an  $n$  to  $2^n$  binary decoder. What size decoder is used in each case?
  - a)  $f(A, B) = \sum m(0,3)$   
 $g(A, B) = \sum m(0,2,3)$
  - b)  $f(A, B) = \prod M(0,3)$   
 $g(A, B) = \prod M(0,2,3)$
  - c)  $f(A, B, C) = \sum m(1,4,6,7)$   
 $g(A, B, C) = \sum m(1,2,3,4,6,7)$
  - d)  $f(A, B, C) = \prod M(1,4,6,7)$   
 $g(A, B, C) = \prod M(1,2,3,4,6,7)$
  - e)  $f(w, x, y, z) = \sum m(1,9,10,12,15)$   
 $g(w, x, y, z) = \sum m(6,7,12,13,14)$   
 $h(w, x, y, z) = \sum m(1,2,3,4,5)$
  - f)  $f(w, x, y, z) = \prod M(1,9,10,12,15)$   
 $g(w, x, y, z) = \prod M(6,7,12,13,14)$   
 $h(w, x, y, z) = \prod M(1,2,3,4,5)$
7. Given the following decimal numbers, what is there equivalent representation as a Binary Coded Decimal (BCD)?
  - a)  $7_{10}$
  - b)  $25_{10}$
  - c)  $84_{10}$
  - d)  $369_{10}$
  - e)  $158_{10}$
  - f)  $6,782_{10}$

8. Give the full truth table for a BCD-to-7-segment display , active low decoder. Based on the table, design and implement the minimum SOP and POS implementations for the following outputs: Which version produces the minimum cost?
- a)  $c(B_3B_xB_1B_0)$       b)  $a(B_3B_xB_1B_0)$       c)  $g(B_3B_xB_1B_0)$
9. Another type of decoder is a Binary-to-7-segment display, active high decoder that inputs all 16 hexadecimal numbers and decodes them to the 7-segment display. Give the full truth table for this decoder and implement the following output functions
- a)  $e(B_3B_xB_1B_0)$       b)  $a(B_3B_xB_1B_0)$       c)  $d(B_3B_xB_1B_0)$
10. Decoders are often used to implement Read-Only Memory (ROM) devices. ROM has the property that it cannot be written to (changed), only read from. It is a place of permanent storage for information. ROM has many storage locations, called Addresses. Each address has  $m$  bits of information, stored as a sequence of 0's and 1's. The way to access each address is to use a decoder. Complete the schematic below of the ROM device that has 32 addresses, each storing 4-bits of information.



## Encoders

11. Describe the general purpose of an encoder. How is an encoder like a decoder? When can a decoder be called an encoder?
12. Construct a truth table for an 8-to-3 line encoder and implement each output by finding the minimum SOP expression.
13. Construct a truth table for a 16-to-3 line encoder with 4 outputs (including the Z output). Design the minimum SOP expression for each output signal. Show your schematic.