

Converting Between Decimal and Binary
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Dartmouth College Department of Mathematics

Convert the following into binary:

2

Convert the following from binary:

1010

6

0101

8

0011

11

1101

46

110001

53

101111

Convert your favorite number here:

Binary Addition and Multiplication
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Addition in binary:

$$\begin{array}{r} 0101 \\ +1001 \\ \hline \end{array}$$

Multiplication in binary:

$$\begin{array}{r} 0011 \\ \times 0101 \\ \hline \end{array}$$

$$\begin{array}{r} 1010 \\ +1001 \\ \hline \end{array}$$

$$\begin{array}{r} 0010 \\ \times 0110 \\ \hline \end{array}$$

$$\begin{array}{r} 1011 \\ +0011 \\ \hline \end{array}$$

$$\begin{array}{r} 1101 \\ \times 0011 \\ \hline \end{array}$$

$$\begin{array}{r} 0111 \\ +0111 \\ \hline \end{array}$$

$$\begin{array}{r} 0110 \\ \times 1011 \\ \hline \end{array}$$

Letters, Symbols, and Digits Barcode Encodings

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Symbol	Binary	Symbol	Binary
[space]	00000	p	10000
a	00001	q	10001
b	00010	r	10010
c	00011	s	10011
d	00100	t	10100
e	00101	u	10101
f	00110	v	10110
g	00111	w	10111
h	01000	x	11000
i	01001	y	11001
j	01010	z	11010
k	01011	!	11011
l	01100	?	11100
m	01101	.	11101
n	01110	,	11110
o	01111	☺	11111

Digit	2 in 5	Digit	2 in 5
0	01100	5	00110
1	11000	6	10001
2	10100	7	01001
3	10010	8	00101
4	01010	9	00011

(7,4) Hamming Code

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The (7,4) Hamming code starts with a 4 digit binary message $abcd$ and then computes 3 check digits $x = a+b+c \pmod{2}$, $y = a+b+d \pmod{2}$, and $z = a+c+d \pmod{2}$ so the final message is $abcdxyz$.

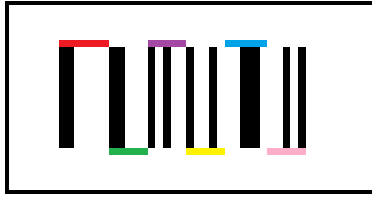
Original Word	$a+b+c=x$	$a+b+d=y$	$a+c+d=z$	Hamming Code
0000	0	0	0	0000-000
0001	0	1	1	0001-011
0010	1	0	1	0010-101
0011	1	1	0	0011-110
0100	1	1	0	0100-110
0101	1	0	1	0101-101
0110	0	1	1	0110-011
0111	0	0	0	0111-000
1000	1	1	1	1000-111
1001	1	0	0	1001-100
1010	0	1	0	1010-010
1011	0	0	1	1011-001
1100	0	0	1	1100-001
1101	0	1	0	1101-010
1110	1	0	0	1110-100
1111	1	1	1	1111-111

Barcode Activities

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- (1) What famous sequence is encoded using the 2 in 5 binary embedding below?

11000 – 11000 – 10100 – 10010 – 00110 – 00101



- (2) Write your birthday in MM/DD/YY format: _____
(3) Using the 2 in 5 encoding write the binary words for your birthday digits:
-

- (4) Draw the barcode for your birthday:

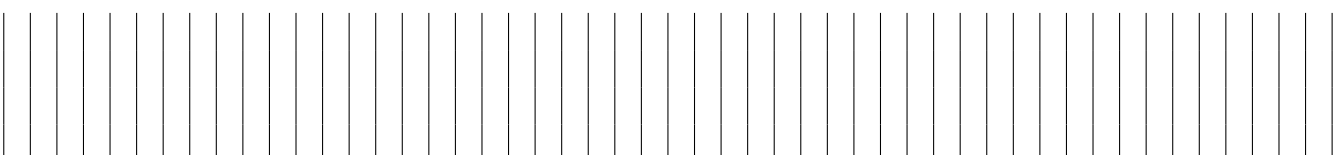
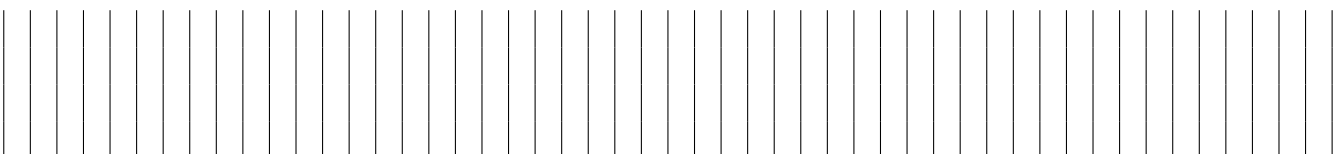
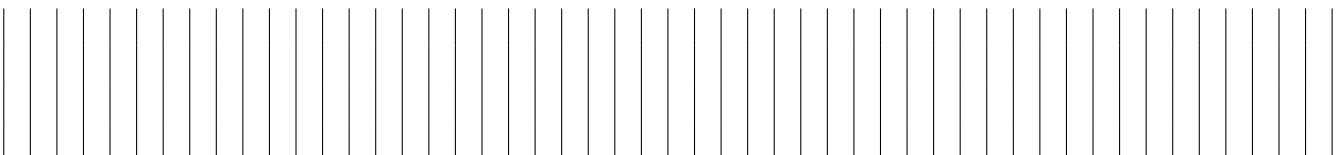
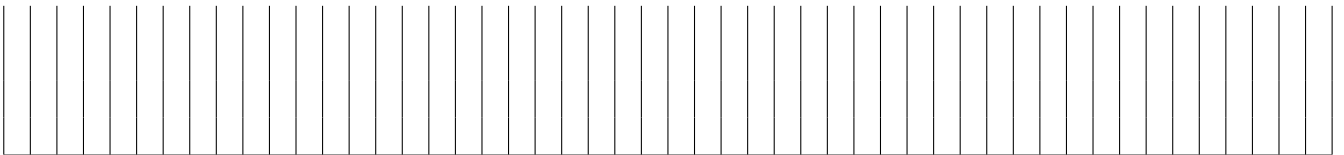
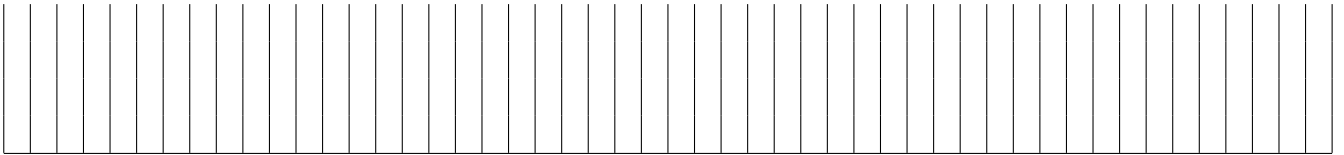
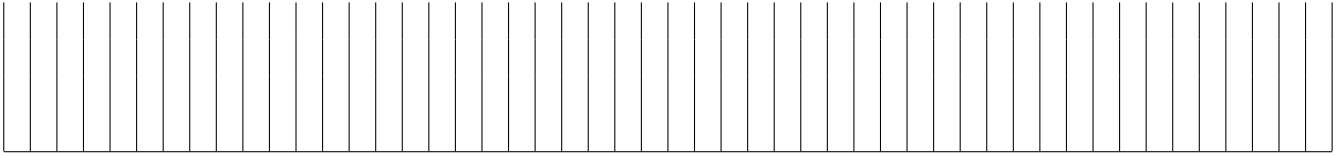
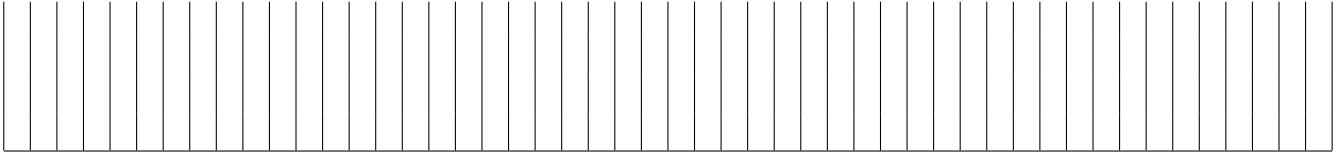
- (5) What phrase is encoded using the simple binary embedding?

01101 – 00001 – 10100 – 01000 – 00000 –
01001 – 10011 – 00000 – 00110 – 10101 – 01110 – 11011

- (6) Write the binary representation of your first name:
-

- (7) Draw the barcode for your name:

Make Your Own Barcodes
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Checksums and Error Correcting Codes
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- (1) Compute the binary check digit for the string 100101.
- (2) Each of the following strings was sent with 5 regular digits and 1 check digit and at most one error per string occurred during transmission. Circle the strings that were transmitted correctly:
- (a) 100110
 - (b) 110101
 - (c) 100110
 - (d) 01110
 - (e) 11111
- (3) The following numbers were sent with a repeated version of the 2 in 5 code. What were the original numbers?

11011 – 10101 – 10000 – 00000 – 00001
00000 – 10011 – 00010 – 00100 – 11111

- (4) Use the multi-dimensional code to write the full message that you would send for the string 1001101000110111

