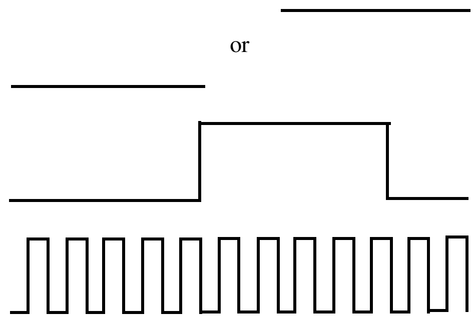
CHAPTER 1

1-1. (a)

(1) Calm: or

(2) 10 mph

(3) 100 mph



(b) The microcomputer requires a table or equation for converting from rotations/second to miles/hour. The pulses produced by the rotating disk must be counted over a known period of time, and the table or equation used to convert the binary count to miles per hour.

1-2.

–34° quantizes to –30° => 1 V => 0001

+31° quantizes to +30° => 7 V => 0111

+77° quantizes to +80° => 12 V => 1100

+108° quantizes to +110° => 15 V => 1111

1-3.*

Decimal, Binary, Octal and Hexadecimal Numbers from $(16)_{10}$ to $(31)_{10}$

Dec	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Bin	1 0000	1 0001	1 0010	1 0011	1 0100	1 0101	1 0110	1 0111	1 1000	1 1001	1 1010	1 1011	1 1100	1 1101	1 1110	1 1111
Oct	20	21	22	23	24	25	26	27	30	31	32	33	34	35	36	37
Hex	10	11	12	13	14	15	16	17	18	19	1A	1B	1C	1D	1E	1F

1-4.

$$96K = 96 \times 2^{10} = 98,304\ Bits$$
$$640M = 640 \times 2^{20} = 671,088,640\ Bits$$
$$4G = 4 \times 2^{30} = 4,294,967,296\ Bits$$

1-5.

$2^{20} = (1{,}000{,}000_{10} + d)$ where $d = 48{,}576$

$$1\text{Tb} = 2^{40} = (2^{20})^2 = (1{,}000{,}000 + d)^2$$
$$= (1{,}000{,}000)^2 + 2(1{,}000{,}000)\,d + d^2$$
$$= 1{,}000{,}000{,}000{,}000$$
$$+ \quad 97{,}152{,}000{,}000$$
$$+ \quad 2{,}359{,}627{,}776$$
$$= 1{,}099{,}511{,}627{,}776$$

1-6.

$$11\ 1\ Bits \Rightarrow 2^{11} - 1 = 2047$$
$$25\ 1\ Bits \Rightarrow 2^{25} - 1 = 33,554,431$$

1-7.*

$(1001101)_2 = 2^6 + 2^3 + 2^2 + 2^0 = 77$

$(1010011.101)_2 = 2^6 + 2^4 + 2^1 + 2^0 + 2^{-1} + 2^{-3} = 83.625$

$(10101110.1001)_2 = 2^7 + 2^5 + 2^3 + 2^2 + 2^1 + 2^{-1} + 2^{-4} = 174.5625$

1-8.

2|193	1	→ 11000001
2|96	0	
2|48	0	
2|24	0	
2|12	0	
2|6	1	
2|1	1	
0		

2|751	1	→ 1011101111
2|375	1	
2|187	1	
2|93	1	
2|46	0	
2|23	1	
2|11	1	
2|5	1	
2|2	0	
2|1	1	
0		

2|2007	1	→ 11111010111
2|1003	1	
2|501	1	
2|250	0	
2|125	1	
2|62	0	
2|31	1	
2|15	1	
2|7	1	
2|3	1	
2|1	1	
0		

2|19450	0	→ 100101111111010
2|9725	1	
2|4862	0	
2|2431	1	
2|1215	1	
2|607	1	
2|303	1	
2|151	1	
2|75	1	
2|37	1	
2|18	0	
2|9	1	
2|4	0	
2|2	0	
2|1	1	
0		

1-9.*

Decimal	Binary	Octal	Hexadecimal
369.3125	101110001.0101	561.24	171.5
189.625	10111101.101	275.5	BD.A
214.625	11010110.101	326.5	D6.A
62407.625	1111001111000111.101	171707.5	F3C7.A

1-10.*

a)

8|7562	2	→ 16612
8|945	1	
8|118	6	
8|14	6	
8|1	1	
0		

$0.45 \times 8 = 3.6 \Rightarrow 3$

$0.60 \times 8 = 4.8 \Rightarrow 4$

$0.80 \times 8 = 6.4 \Rightarrow 6$

$0.20 \times 8 = 3.2 \Rightarrow 3$ → 3463

$(7562.45)_{10} = (16612.3463)_8$

b) $(1938.257)_{10} = (792.41CB)_{16}$

c) $(175.175)_{10} = (10101111.001011)_2$

1-11.*

a) $(673.6)_8 = (110\ 111\ 011.110)_2$

$= (1BB.C)_{16}$

b) $(E7C.B)_{16} = (1110\ 0111\ 1100.1011)_2$

$= (7174.54)_8$

c) $(310.2)_4 = (11\ 01\ 00.10)_2$

$= (64.4)_8$

1-12.

a)
```
      1101
     ×1011
      1101
     1101
    0000
   1101
  10001111
```

b)
```
      0101
     ×1010
      0000
     0101
    0000
   0101
   0110010
```

c)
```
        100111
       ×011011
        100111
       100111
      000000
     100111
    100111
   000000
   10000011101
```

1-13.+

```
       10001        Quotient = 10001
101 )1010110
    −101            Remainder = 1
      000
     −000
       001
      −000
        011
       −000
         110
        −101
           1
```

1-14.

(a) $6 \times 12^3 + 8 \times 12^2 + 7 \times 12^1 + 4 = 11608$

(b)
```
12|7569  9    → 4469_12
 12|630  6
  12|52  4
   12|4  4
       0
```

4469_{12}

1-15.

a)

0	1	2	3	4	5	6	7	8	9
A	B	C	D	E	F	G	H	I	J

b)
```
20|2007  7   → 507_20
 20|100  0
   20|5  5
       0
```

507_{20}

c) $(BCI.G)_{20} = 11 \times 20^2 + 12 \times 20^1 + 18 \times 20^0 + 16 \times 20^{-1} = (4658.8)_{10}$

1-16.*

a) $(\text{BEE})_r = (2699)_{10}$

$11 \times r^2 + 14 \times r^1 + 14 \times r^0 = 2699$

$11 \times r^2 + 14 \times r - 2685 = 0$

By the quadratic equation: $r = 15$ or ≈ -16.27

ANSWER: $r = 15$

b) $(365)_r = (194)_{10}$

$3 \times r^2 + 6 \times r^1 + 5 \times r^0 = 194$

$$3 \times r^2 + 6 \times r - 189 = 0$$

By the quadratic equation: $r = -9$ or 7

ANSWER: r = 7

1-17.

Noting the order of operations, first add $(34)_r$ and $(24)_r$

$$(34)_r = 3 \times r^1 + 4 \times r^0$$

$$(24)_r = 2 \times r^1 + 4 \times r^0$$

$$(34)_r + (24)_r = 5 \times r^1 + 8 \times r^0$$

Now, multiply the result by $(21)_r$

$$(2 \times r^1 + 1 \times r^0) \times (5 \times r^1 + 8 \times r^0) = 10 \times r^2 + 23 \times r^1 + 8$$

Next, set the result equal to $(1480)_r$ and reorganize.

$$10 \times r^2 + 23 \times r^1 + 8 = 1 \times r^3 + 4 \times r^2 + 8 \times r^1$$

$$1 \times r^3 - 6 \times r^2 - 15 \times r^1 - 8 \times r^0 = 0$$

Finally, find the roots of this cubic polynomial.

Solutions are: r = 8, – 1, – 1

ANSWER: The chicken has 4 toes on each foot (half of 8).

1-18.*

a) $(0100\ 1000\ 0110\ 0111)_{BCD} = (4867)_{10}$

$= (1001100000011)_2$

b) $(0011\ 0111\ 1000.0111\ 0101)_{BCD} = (378.75)_{10}$

$= (101111010.11)_2$

1-19.*

$(694)_{10} = (0110\ 1001\ 0100)_{BCD}$

$(835)_{10} = (1000\ 0011\ 0101)_{BCD}$

	1 ← (carry)		
	0110	1001	0100
	+1000	+0011	+0101
	1111	1100	1001
	+0110	+0110	+0000
0001	0101	1 0010	1001

1-20.*

(a)

	10^1	10^0		
	0111	1000		
Move R	011	1100	0	10^0 column > 0111
Subtract 3		-0011		
	011	1001	0	
Subtract 3		-0011		
	01	1001		
Move R	0	1100	110	10^0 column > 0111
Subtract 3		-0011		
	0	1001	110	
Move R		0100	1110	
Move R		010	01110	
Move R		01	001110	
Move R		0	1001110	Leftmost 1 in BCD number shifted out: Finished

(b)

	10^2	10^1	10^0		
	0011	1001	0111		
Move R	001	1100	1011	1	10^1 and 10^0 columns > 0111
Subtract 3		-0011	-0011		
	001	1001	1000	1	
Move R	00	1100	1100	01	10^1 and 10^0 columns > 0111

Subtract 3	-0011 -0011		
	00 1001 1001	01	
Move R	0 0100 1100	101	10^0 column > 0111
Subtract 3	-0011		
	0 0100 1001		
Move R	0010 0100	1101	
Move R	001 0010	01101	
Move R	00 1001	001101	100 column > 0111
Subtract 3	-0011		
	00 0110	001101	
Move R	0 0011	0001101	
Move R	0001	10001101	
Move R	000	110001101	Leftmost 1 in BCD number shifted out: Finished

1-21.

(a)

	10^2	10^1	10^0		
				1111000	
1st Move L			1	111000	
2nd Move L			11	11000	
3rd Move L			111	1000	10^0 column > 100
Add 3			0011		
			1010	1000	
4th Move L		1	0101	000	10^0 column > 100
Add 3			0011		
		1	1000	000	
5th Move L		11	0000	00	
6th Move L		110	0000	0	10^1 column > 100
Add 3		0011			
		1001	0000	0	
7th Move L	1	0010	0000		Least significant bit in binary number moved in:Finished

(b)

	10^3	10^2	10^1	10^0		
					01110010111	
1st Move L				0	1110010111	
2nd Move L				01	110010111	
3rd Move L				011	10010111	
4th Move L				0111	0010111	10^0 column > 100
Add 3				0011		
				1010	0010111	
5th Move L			1	0100	010111	
6th Move L			10	1000	10111	10^0 column > 100
Add 3				0011		
			10	1011	10111	
7th Move L			101	0111	0111	10^1 & 10^0 columns > 100
Add 3			0011	0011		
			1000	1010	0111	
8th Move L		1	0001	0100	111	
9th Move L		10	0010	1001	11	10^0 column > 100
Add 3				0011		
		10	0010	1100	11	
10th Move L		100	0101	1001	1	10^1 &10^0 columns > 100
Add 3			0011	0011		
		100	1000	1100	1	
11th Move L		1001	0001	1001	Least significant bit in binary number moved in: Finished	

1-22.

From Table 1-5, complementing the bit B_6 will switch an uppercase letter to a lower case letter and vice versa.

1-23.

a) The name used is Brent M. Ledvina. An alternative answer: use both upper and lower case letters.

0100 0010 B 0101 0010 R 0100 0101 E

0100	1110	N	0101	0100	T	0010	0000	(SP)
0100	1101	M	0010	1110	.	0010	0000	(SP)
0100	1100	L	0100	0101	E	0100	0100	D
0101	0110	V	0100	1001	I	0100	1110	N
0100	0001	A						

b)

0100	0010	1101	0010	1100	0101
0100	1110	1101	0100	1010	0000
0100	1101	0010	1110	1010	0000
1100	1100	1100	0101	0100	0100
0101	0110	1100	1001	0100	1110
0100	0001				

1-24.

1000111	G
1101111	o
0100000	
1000010	B
1100001	a
1100100	d
1100111	g
1100101	e
1110010	r
1110011	s
0100001	!

1-25.*

a) $(11111111)_2$

b) $(0010\ 0101\ 0101)_{BCD}$

c) 011 0010 011 0101 $011\ 0101_{ASCII}$

d) 0011 0010 1011 0101 $1011\ 0101_{\text{ASCII with Odd Parity}}$

1-26.

Binary Numbers from $(32)_{10}$ to $(47)_{10}$ with Odd and Even Parity

Decimal	32	33	34	35	36	37	38	39
(a) Odd	100000 0	100001 1	100010 1	100011 0	100100 1	100101 0	100110 0	100111 1
(b) Even	100000 1	100001 0	100010 0	100011 1	100100 0	100101 1	100110 1	100111 0
Decimal	40	41	42	43	44	45	46	47
(a) Odd	101000 1	101001 0	101010 0	101011 1	101100 0	101101 1	101110 1	101111 0
(b) Even	101000 0	101001 1	101010 1	101011 0	101100 1	101101 0	101110 0	101111 1

1-27.

Gray Code for Hexadecimal Digits

Hex	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
Gray	0000	0001	0011	0010	0110	0111	0101	0100	1100	1101	1111	1110	1010	1011	1001	1000

1-28.

(a) Wind Direction Gray Code

Direction	Code Word
N	000
S	110
E	011
W	101
NW	100
NE	001
SW	111
SE	010

(b) Wind Direction Gray Code (directions in adjacent order)

Direction	Code Word
N	000
NE	001
E	011
SE	010
S	110
SW	111
W	101
NW	100

As the wind direction changes, the codes change in the order of the rows of this table, assuming that the bottom row is "next to" the top row. From the table, the codes that result due to a wind direction change always change in a single bit.

1-29.+

The percentage of power consumed by the Gray code counter compared to a binary code counter equals:

$$\frac{\text{Number of bit changes using Gray code}}{\text{Number of bit changes using binary code}}$$

As shown in Table 1-6, and by definition, the number of bit changes per cycle of an n-bit Gray code counter is 1 per count = 2^n.

$$\text{Number of bit changes using Gray code} = 2^n$$

For a binary counter, notice that the least significant bit changes on every increment. The second least significant bit changes on every other increment. The third digit changes on every fourth increment of the counter, and so on. As shown in Table 1-6, the most significant digit changes twice per cycle of the binary counter.

$$\text{Number of bit changes using binary code } 2^n + 2^{n-1} + \ldots + 2^1$$

$$= \sum_{i=1}^{n} 2^i = \left[\sum_{i=0}^{n} 2^i\right] - 1 = (2^{(n+1)} - 1) - 1 = 2^{n+1} - 2$$

$$\%\ \text{Power} = \frac{2^n}{2^{(n+1)} - 2} \times 100$$