CHAPTER 1

1.1

Base-10:	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
Octal:	20	21	22	23	24	25	26	27	30	31	32	33	34	35	36	37	40
Hex:	10	11	12	13	14	15	16	17	18	19	1A	1B	1C	1D	1E	1F	20
Base-13	A	B	C	10	11	12	13	14	15	16	17	18	19	23	24	25	26

1.2 **(a)** 32,768 **(b)** 67,108,864 **(c)** 6,871,947,674

1.3 $(4310)_5 = 4 * 5^3 + 3 * 5^2 + 1 * 5^1 = 580_{10}$

$(198)_{12} = 1 * 12^2 + 9 * 12^1 + 8 * 12^0 = 260_{10}$

$(735)_8 = 7 * 8^2 + 3 * 8^1 + 5 * 8^0 = 477_{10}$

$(525)_6 = 5 * 6^2 + 2 * 6^1 + 5 * 6^0 = 197_{10}$

1.4 14-bit binary: 11_1111_1111_1111
Decimal: $2^{14}-1 = 16{,}383_{10}$
Hexadecimal: $3FFF_{16}$

1.5 Let b = base

(a) 14/2 = (b + 4)/2 = 5, so b = 6

(b) 54/4 = (5*b + 4)/4 = b + 3, so 5 * b = 52 – 4, and b = 8

(c) (2 *b + 4) + (b + 7) = 4b, so b = 11

1.6 $(x - 3)(x - 6) = x^2 - (6 + 3)x + 6*3 = x^2 - 11x + 22$

Therefore: 6 + 3 = b + 1m so b = 8
Also, $6*3 = (18)_{10} = (22)_8$

1.7 $68BE = 0110\_1000\_1011\_1110 = 110\_100\_010\_111\_110 = (64276)_8$

1.8 **(a)** Results of repeated division by 2 (quotients are followed by remainders):

431_{10} = 215(1); 107(1); 53(1); 26(1); 13(0); 6(1) 3(0) 1(1)
Answer: $1111\_1010_2 = FA_{16}$

(b) Results of repeated division by 16:

431_{10} = 26(15); 1(10) (Faster)
Answer: FA = 1111_1010

1.9 **(a)** $10110.0101_2 = 16 + 4 + 2 + .25 + .0625 = 22.3125$

(b) $16.5_{16} = 16 + 6 + 5*(.0615) = 22.3125$

(c) $26.24_8 = 2 * 8 + 6 + 2/8 + 4/64 = 22.3125$

(d) $FAFA.B_{16} = 15*16^3 + 10*16^2 + 15*16 + 10 + 11/16 = 64{,}250.6875$

(e) $1010.1010_2 = 8 + 2 + .5 + .125 = 10.625$

1.10 **(a)** $1.10010_2 = 0001.1001_2 = 1.9_{16} = 1 + 9/16 = 1.563_{10}$

(b) $110.010_2 = 0110.0100_2 = 6.4_{16} = 6 + 4/16 = 6.25_{10}$

Reason: 110.010_2 is the same as 1.10010_2 shifted to the left by two places.

1.11

```
     1011.11
101 | 111011.0000
      101
      01001
       101
        1001
         101
          1000
           101
            0110
```

The quotient is carried to two decimal places, giving 1011.11
Checking: $111011_2 / 101_2 = 59_{10} / 5_{10} \cong 1011.11_2 = 58.75_{10}$

1.12 **(a)** 10000 and 110111

```
  1011          1011
 +101          x101
 -----         -----
 10000 = 16    1011
              1011
              ------
              110111 = 55
```

(b) 62_h and 958_h

```
 2E_h   0010_1110          2E_h
+34_h   0011_0100         x34_h
 ----   ---------         -----
 62_h   0110_0010 = 98     B^3 8
                          8^2 A
                          -----
                          9  5 8_h = 2392
```

1.13 **(a)** Convert 27.315 to binary:

	Integer Quotient		Remainder	Coefficient
27/2 =	13	+	½	$a_0 = 1$
13/2	6	+	½	$a_1 = 1$
6/2	3	+	0	$a_2 = 0$
3/2	1	+	½	$a_3 = 1$
½	0	+	½	$a_4 = 1$

$27_{10} = 11011_2$

		Integer		Fraction	Coefficient
.315 x 2	=	0	+	.630	$a_{-1} = 0$
.630 x 2	=	1	+	.26	$a_{-2} = 1$
.26 x 2	=	0	+	.52	$a_{-3} = 0$
.52 x 2	=	1	+	.04	$a_{-4} = 1$

$.315_{10} \cong .0101_2 = .25 + .0625 = .3125$

$27.315 \cong 11011.0101_2$

(b) 2/3 ≅ .6666666667

		Integer		Fraction	Coefficient
.6666_6666_67 x 2	=	1	+	.3333_3333_34	$a_{-1} = 1$
.3333333334 x 2	=	0	+	.6666666668	$a_{-2} = 0$
.6666666668 x 2	=	1	+	.3333333336	$a_{-3} = 1$
.3333333336 x 2	=	0	+	.6666666672	$a_{-4} = 0$
.6666666672 x 2	=	1	+	.3333333344	$a_{-5} = 1$
.3333333344 x 2	=	0	+	.6666666688	$a_{-6} = 0$
.6666666688 x 2	=	1	+	.3333333376	$a_{-7} = 1$
.3333333376 x 2	=	0	+	.6666666752	$a_{-8} = 0$

$.6666666667_{10} \cong .10101010_2 = .5 + .125 + .0313 + ..0078 = .6641_{10}$

$.101010102 = .1010\_1010_2 = .AA_{16} = 10/16 + 10/256 = .6641_{10}$ (Same as (b)).

1.14 **(a)** 1000_0000
1s comp: 0111_1111
2s comp: 1000_0000

(b) 0000_0000
1s comp: 1111_1111
2s comp: 0000_0000

(c) 1101_1010
1s comp: 0010_0101
2s comp: 0010_0110

(d) 0111_0110
1s comp: 1000_1001
2s comp: 1000_1010

(e) 1000_0101
1s comp: 0111_1010
2s comp: 0111_1011

(f) 1111_1111
1s comp: 0000_0000
2s comp: 0000_0001

1.15 **(a)** 52,784,630
9s comp: 47,215,369
10s comp: 47,215,370

(b) 63,325,600
9s comp: 36,674,399
10s comp: 36,674,400

(c) 25,000,000
9s comp: 74,999,999
10s comp: 75,000,000

(d) 00,000,000
9s comp: 99,999,999
10s comp: 00,000,000

1.16 B2FA
15s comp: 4D05
16s comp: 4D06

B2FA: 1011_0010_1111_1010
1s comp: 0100_1101_0000_0101
2s comp: 0100_1101_0000_0110 = 4D06

1.17 **(a)** 3409 → 03409 →96590 (9s comp) → 96591 (10s comp)
06428 – 03409 = 06428 + 96591 = 03019

(b) 1800 → 01800 → 98199 (9s comp) → 98200 (10 comp)
125 – 1800 = 00125 + 98200 = 98325 (negative)
Magnitude: 1675
Result: 125 – 1800 = 1675

(c) 6152 → 06152 → 93847 (9s comp) → 93848 (10s comp)
2043 – 6152 = 02043 + 93848 = 95891 (Negative)
Magnitude: 4109
Result: 2043 – 6152 = -4109

(d) 745 → 00745 → 99254 (9s comp) → 99255 (10s comp)
1631 -745 = 01631 + 99255 = 0886 (Positive)
Result: 1631 – 745 = 886

1.18 Note: Consider sign extension with 2s complement arithmetic.

(a)
10001
1s comp: 01110
2s comp: 01111
10011
Diff: 00010

(b)
100011
1s comp: 1011100 with sign extension
2s comp: 1011101
0100010
1111111 sign bit indicates that the result is negative
0000001 2s complement
-000001 result

(c)
101000
1s comp: 1010111
2s comp: 1011000
001001
Diff: 1100001 (negative)
0011111 (2s comp)
-011111 (diff is -31)

(d)
10101
1s comp: 1101010 with sign extension
2s comp: 1101011
110000
0011011 sign bit indicates that the result is positive
Check: 48 -21 = 27

1.19 +9286 → 009286; +801 → 000801; -9286 → 990714; -801 → 999199

(a) (+9286) + (_801) = 009286 + 000801 = 010087

(b) (+9286) + (-801) = 009286 + 999199 = 008485

(c) (-9286) + (+801) = 990714 + 000801 = 991515

(d) (-9286) + (-801) = 990714 + 999199 = 989913

1.20 +49 → 0_110001 (Needs leading zero indicate + value); +29 → 0_011101 (Leading 0 indicates + value)
-49 → 1_001111; -29 → 1_100011

(a) (+29) + (-49) = 0_011101 + 1_001111 = 1_101100 (1 indicates negative value.)
Magnitude = 0_010100; Result (+29) + (-49) = -20

(b) (-29) + (+49) = 1_100011 + 0_110001 = 0_010100 (0 indicates positive value)
(-29) + (+49) = +20

(c) Must increase word size by 1 (sign extension) to accomodate overflow of values:
(-29) + (-49) = 11_100011 + 11_001111 = 10_110010 (1 indicates negative result)
Magnitude: 1_001110 = 78_{10}
Result: (-29) + (-49) = -78

1.21 +9742 → 009742 → 990257 (9's comp) → 990258 (10s) comp
+641 → 000641 → 999358 (9's comp) → 999359 (10s) comp

(a) (+9742) + (+641) → 010383

(b) (+9742) + (-641) →009742 + 999359 = 009102
Result: (+9742) + (-641) = 9102

(c) -9742) + (+641) = 990258 + 000641 = 990899 (negative)
Magnitude: 009101
Result: (-9742) + (641) = -9101

(d) (-9742) + (-641) = 990258 + 999359 = 989617 (Negative)
Magnitude: 10383
Result: (-9742) + (-641) = -10383

1.22 8,723
BCD: 1000_0111_0010_0011
ASCII: 0_011_1000_011_0111_011_0010_011_0001

1.23

	1000	0100	0010 (842)
	0101	0011	0111 (+537)
	1101	0111	1001
	0110		
0001	0011	0111	0101 (1,379)

1.24

(a)

6	3	1	1	Decimal
0	0	0	0	0
0	0	0	1	1
0	0	1	0	2
0	1	0	0	3
0	1	1	0	4 (*or* 0101)
0	1	1	1	5
1	0	0	0	6
1	0	1	0	7 (*or* 1001)
1	0	1	1	8
1	1	0	0	9

(b)

6	4	2	1	Decimal
0	0	0	0	0
0	0	0	1	1
0	0	1	0	2
0	0	1	1	3
0	1	0	0	4
0	1	0	1	5
1	0	0	0	6 (*or* 0110)
1	0	0	1	7
1	0	1	0	8
1	0	1	1	9

1.25

(a)	$5{,}137_{10}$	BCD:	0101_0011_0111
(b)		Excess-3:	1000_0100_0110_1010
(c)		2421:	1011_0001_0011_0111
(d)		6311:	0111_0001_0100_1001

1.26 5,137 9s Comp: 4,862
2421 code: 0100_1110_1100_1000
1s comp: 1011_0001_0011_0111 same as (c) in 1.25

1.27 For a deck with 52 cards, we need 6 bits (32 < 52 < 64). Let the msb's select the suit (e.g., diamonds, hearts, clubs, spades are encoded respectively as 00, 01, 10, and 11. The remaining four bits select the "number" of the card. Example: 0001 (ace) through 1011 (9), plus 101 through 1100 (jack, queen, king). This a jack of spades might be coded as 11_1010. (Note: only 52 out of 64 patterns are used.)

1.28

G	(dot)	(space)	B	o	o	l	e
01000111_	11101111_	01101000_	01101110_	00100000_	11000100_	11101111_	11100101

1.29 Bill Gates

1.30 73 F4 E5 76 E5 4A EF 62 73

73:	0_111_0011	s
F4:	1_111_0100	t
E5:	1_110_0101	e
76:	0_111_0110	v
E5:	1_110_0101	e
4A:	0_100_1010	j
EF:	1_110_1111	o
62:	0_110_0010	b
73:	0_111_0011	s

1.31 62 + 32 = 94 printing characters

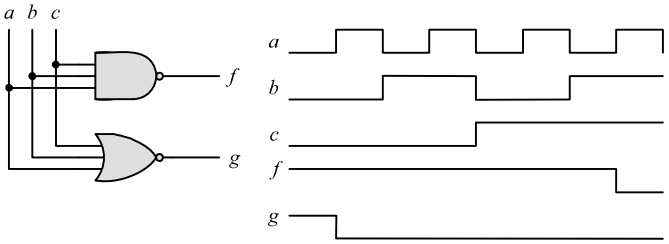
1.32 bit 6 from the right

1.33 **(a)** 897 **(b)** 564 **(c)** 871 **(d)** 2,199

1.34 ASCII for decimal digits with odd parity:

(0):	10110000	(1):	00110001	(2):	00110010	(3):	10110011
(4):	00110100	(5):	10110101	(6):	10110110	(7):	00110111
(8):	00111000	(9):	10111001				

1.35 **(a)**



1.36