

# APPENDIX A

## Numerical considerations

2's complement	Decimal value	Excess-3
101	-3	000
110	-2	001
111	-1	010
000	0	011
001	1	100
010	2	101
011	3	110
100	Reserved pattern	111

**FIGURE A.1**

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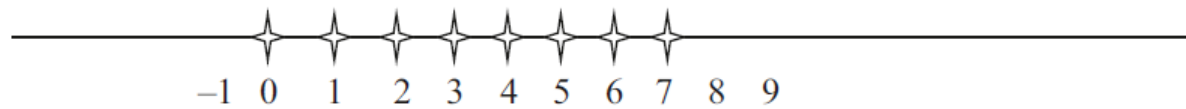
Excess-3 encoding, sorted by excess-3 ordering.

000	0
001	1
010	2
011	3
100	4
101	5
110	6
111	7

**FIGURE A.2**

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Representable numbers of a 3-bit unsigned integer format.



**FIGURE A.3**

Representable numbers of a 3-bit unsigned integer format.

		No-zero		Abrupt underflow		Denormalized	
E	M	S=0	S=1	S=0	S=1	S=0	S=1
00	00	$2^{-1}$	$-(2^{-1})$	0	0	0	0
	01	$2^{-1}+1*2^{-3}$	$-(2^{-1}+1*2^{-3})$	0	0	$1*2^{-2}$	$-1*2^{-2}$
	10	$2^{-1}+2*2^{-3}$	$-(2^{-1}+2*2^{-3})$	0	0	$2*2^{-2}$	$-2*2^{-2}$
	11	$2^{-1}+3*2^{-3}$	$-(2^{-1}+3*2^{-3})$	0	0	$3*2^{-2}$	$-3*2^{-2}$
01	00	$2^0$	$-(2^0)$	$2^0$	$-(2^0)$	$2^0$	$-(2^0)$
	01	$2^0+1*2^{-2}$	$-(2^0+1*2^{-2})$	$2^0+1*2^{-2}$	$-(2^0+1*2^{-2})$	$2^0+1*2^{-2}$	$-(2^0+1*2^{-2})$
	10	$2^0+2*2^{-2}$	$-(2^0+2*2^{-2})$	$2^0+2*2^{-2}$	$-(2^0+2*2^{-2})$	$2^0+2*2^{-2}$	$-(2^0+2*2^{-2})$
	11	$2^0+3*2^{-2}$	$-(2^0+3*2^{-2})$	$2^0+3*2^{-2}$	$-(2^0+3*2^{-2})$	$2^0+3*2^{-2}$	$-(2^0+3*2^{-2})$
10	00	$2^1$	$-(2^1)$	$2^1$	$-(2^1)$	$2^1$	$-(2^1)$
	01	$2^1+1*2^{-1}$	$-(2^1+1*2^{-1})$	$2^1+1*2^{-1}$	$-(2^1+1*2^{-1})$	$2^1+1*2^{-1}$	$-(2^1+1*2^{-1})$
	10	$2^1+2*2^{-1}$	$-(2^1+2*2^{-1})$	$2^1+2*2^{-1}$	$-(2^1+2*2^{-1})$	$2^1+2*2^{-1}$	$-(2^1+2*2^{-1})$
	11	$2^1+3*2^{-1}$	$-(2^1+3*2^{-1})$	$2^1+3*2^{-1}$	$-(2^1+3*2^{-1})$	$2^1+3*2^{-1}$	$-(2^1+3*2^{-1})$
11	Reserved pattern						

**FIGURE A.4**

Representable numbers of no-zero, abrupt underflow, and denormalized formats.



**FIGURE A.5**

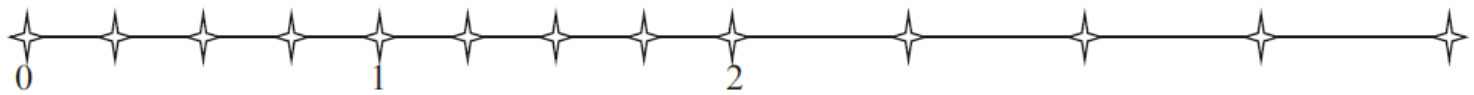
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Representable numbers of the no-zero representation.



**FIGURE A.6**

Representable numbers of the abrupt underflow format.



**FIGURE A.7**

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Representable numbers of a denormalization format.



exponent	mantissa	meaning
11...1	$\neq 0$	NaN
11...1	$=0$	$(-1)^S * \infty$
00...0	$\neq 0$	denormalized
00...0	$=0$	0

**FIGURE A.8**

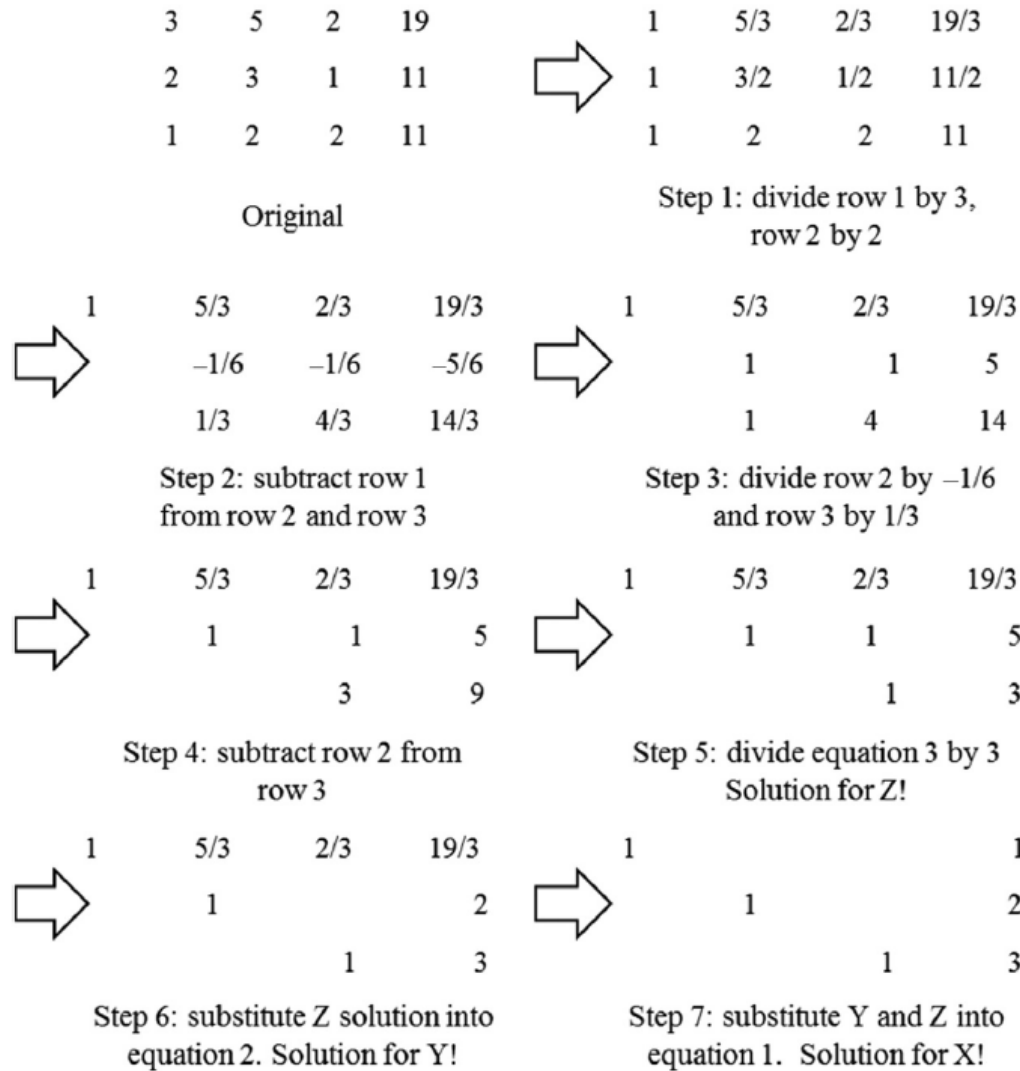
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Special bit patterns in the IEEE standard format.

$  \begin{array}{rrcr}  3X & + 5Y & + 2Z & = 19 \\  2X & + 3Y & + Z & = 11 \\  X & + 2Y & + 2Z & = 11  \end{array}  $ <p style="text-align: center;">Original</p>	$  \begin{array}{rrcr}  X & + 5/3Y & + 2/3Z & = 19/3 \\  X & + 3/2Y & + 1/2Z & = 11/2 \\  X & + 2Y & + 2Z & = 11  \end{array}  $ <p style="text-align: center;">Step 1: divide equation 1 by 3, equation 2 by 2</p>
$  \begin{array}{rrcr}  X & + 5/3Y & + 2/3Z & = 19/3 \\  \Rightarrow & -1/6Y & -1/6Z & = -5/6 \\  & 1/3Y & + 4/3Z & = 14/3  \end{array}  $ <p style="text-align: center;">Step 2: subtract equation 1 from equation 2 and equation 3</p>	$  \begin{array}{rrcr}  X & + 5/3Y & + 2/3Z & = 19/3 \\  & Y & + Z & = 5 \\  & Y & + 4Z & = 14  \end{array}  $ <p style="text-align: center;">Step 3: divide equation 2 by <math>-1/6</math> and equation 3 by <math>1/3</math></p>
$  \begin{array}{rrcr}  X & + 5/3Y & + 2/3Z & = 19/3 \\  \Rightarrow & Y & + Z & = 5 \\  & & + 3Z & = 9  \end{array}  $ <p style="text-align: center;">Step 4: subtract equation 2 from equation 3</p>	$  \begin{array}{rrcr}  X & + 5/3Y & + 2/3Z & = 19/3 \\  & Y & + Z & = 5 \\  & & Z & = 3  \end{array}  $ <p style="text-align: center;">Step 5: divide equation 3 by 3 Solution for Z!</p>
$  \begin{array}{rrcr}  X & + 5/3Y & + 2/3Z & = 19/3 \\  \Rightarrow & Y & & = 2 \\  & & Z & = 3  \end{array}  $ <p style="text-align: center;">Step 6: substitute Z solution into equation 2. Solution for Y!</p>	$  \begin{array}{rrcr}  X & & & = 1 \\  & Y & & = 2 \\  & & Z & = 3  \end{array}  $ <p style="text-align: center;">Step 7: substitute Y and Z into equation 1. Solution for X!</p>

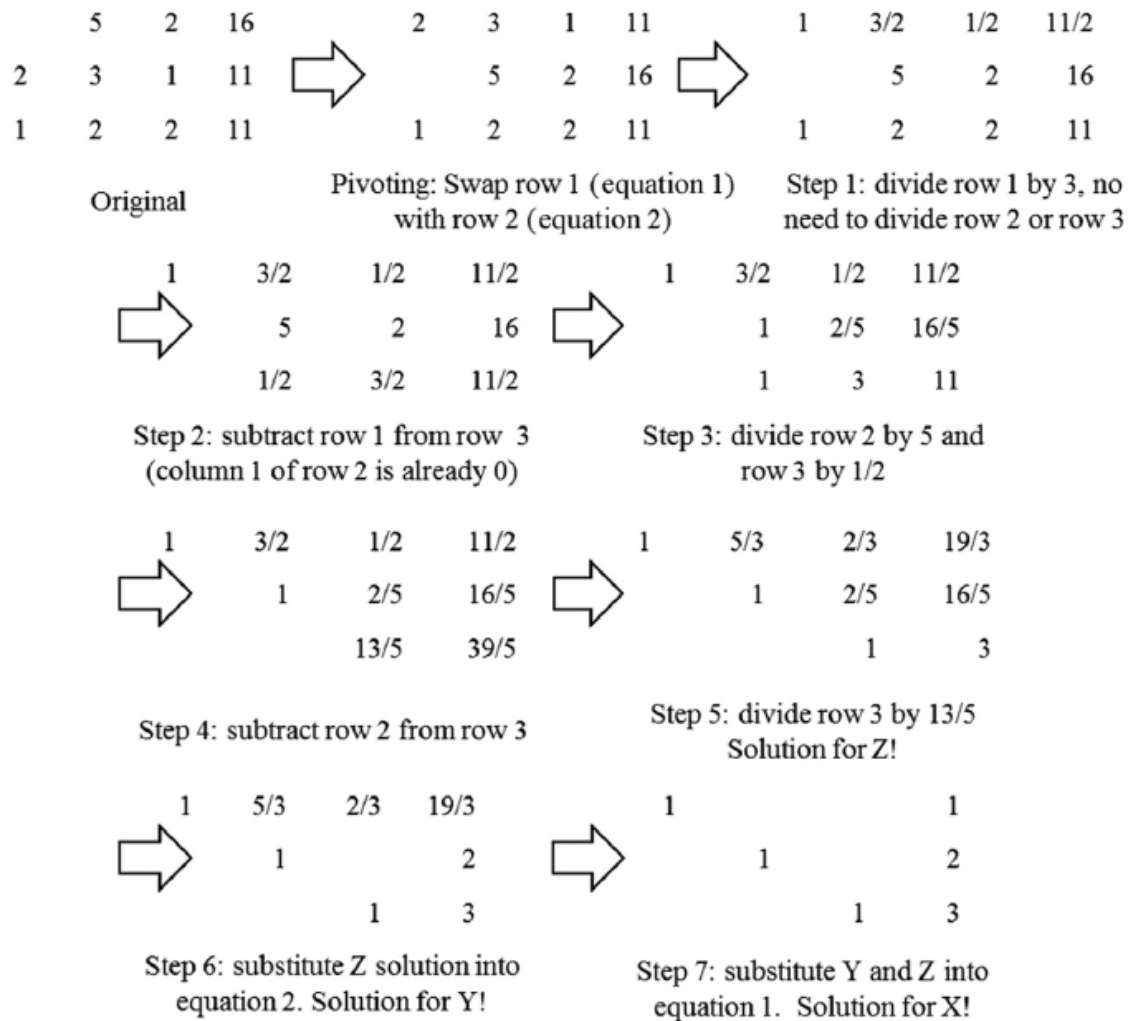
**FIGURE A.9**

Gaussian elimination and backward substitution for solving systems of linear equations.



**FIGURE A.10**

Gaussian elimination and backward substitution in matrix view.



**FIGURE A.11**

Gaussian elimination with pivoting.