COMP 1113 – Illustrative Floating Point Format for Classroom Examples

The full IEEE-754 single, double, and extended precision formats for floating point numbers are too cumbersome for classroom hand-calculation use to explore the properties of this sort of coding form. Instead, we will use a much shorter floating point format that has all of the basic properties of the IEEE formats, but uses only 10 bits of storage.

Floating 10 bits as follows:
 1 bit = sign bit, 1 for – and 0 for +
 4 bits = exponent in bias/excess 7
 5 bits = mantissa

sign	Exponent 4 bits	mantissa 5 bits

The decimal/radix point is at the beginning of the mantissa and there is an assumed/hidden 1 at the beginning of every normalized number.

Some of the bit patterns are reserved as follows:
 ♦ Exponent = 0000 and mantissa ≠ 00000 then the number is in denormalized form and the exponent is assumed to be -6.
 ♦ Exponent = 0000 and mantissa = 00000 then the number is zero (+ or -)
 ♦ Exponent = 1111 and mantissa = 00000 then the number is $\pm\infty$
 ♦ Exponent = 1111 and mantissa ≠ 00000 then NAN (not a number)

IEEE-754 Single Precision (4 byte) Format:

 1 bit to represent the sign of the number (0 for positive, 1 for negative)
 8 bits to code the exponent of the 2, using an excess-127 representation
 23 bits to code the significand/mantissa (with hidden bit)

IEEE-754 Double Precision (8 byte) Format:

 1 bit to represent the sign of the number (0 for positive, 1 for negative)
 11 bits to code the exponent of the 2, using an excess-1023 representation
 52 bits to code the significand (with hidden bit)

Special cases are essentially identical in pattern to the special cases identified for the 10-bit format described in the box above.

Table of ASCII Codes

dec	hex	bin		dec	hex	bin		dec	hex	bin		dec	hex	bin	
0	00	0000 0000		64	40	0100 0000	@	128	80	1000 0000	€	192	C0	1100 0000	À
1	01	0000 0001	⌐	65	41	0100 0001	A	129	81	1000 0001		193	C1	1100 0001	Á
2	02	0000 0010	┐	66	42	0100 0010	B	130	82	1000 0010	,	194	C2	1100 0010	Â
3	03	0000 0011	└	67	43	0100 0011	C	131	83	1000 0011	ƒ	195	C3	1100 0011	Ã
4	04	0000 0100	┘	68	44	0100 0100	D	132	84	1000 0100	„	196	C4	1100 0100	Ä
5	05	0000 0101	│	69	45	0100 0101	E	133	85	1000 0101	…	197	C5	1100 0101	Å
6	06	0000 0110	─	70	46	0100 0110	F	134	86	1000 0110	†	198	C6	1100 0110	Æ
7	07	0000 0111	•	71	47	0100 0111	G	135	87	1000 0111	‡	199	C7	1100 0111	Ç
8	08	0000 1000	▯	72	48	0100 1000	H	136	88	1000 1000	ˆ	200	C8	1100 1000	È
9	09	0000 1001		73	49	0100 1001	I	137	89	1000 1001	‰	201	C9	1100 1001	É
10	0A	0000 1010		74	4A	0100 1010	J	138	8A	1000 1010	Š	202	CA	1100 1010	Ê
11	0B	0000 1011	♂	75	4B	0100 1011	K	139	8B	1000 1011	‹	203	CB	1100 1011	Ë
12	0C	0000 1100		76	4C	0100 1100	L	140	8C	1000 1100	Œ	204	CC	1100 1100	Ì
13	0D	0000 1101		77	4D	0100 1101	M	141	8D	1000 1101		205	CD	1100 1101	Í
14	0E	0000 1110	♫	78	4E	0100 1110	N	142	8E	1000 1110	Ž	206	CE	1100 1110	Î
15	0F	0000 1111	☼	79	4F	0100 1111	O	143	8F	1000 1111		207	CF	1100 1111	Ï
16	10	0001 0000	┼	80	50	0101 0000	P	144	90	1001 0000		208	D0	1101 0000	Ð
17	11	0001 0001	◄	81	51	0101 0001	Q	145	91	1001 0001	'	209	D1	1101 0001	Ñ
18	12	0001 0010	↕	82	52	0101 0010	R	146	92	1001 0010	'	210	D2	1101 0010	Ò
19	13	0001 0011	‼	83	53	0101 0011	S	147	93	1001 0011	"	211	D3	1101 0011	Ó
20	14	0001 0100	¶	84	54	0101 0100	T	148	94	1001 0100	"	212	D4	1101 0100	Ô
21	15	0001 0101	⊥	85	55	0101 0101	U	149	95	1001 0101	•	213	D5	1101 0101	Õ
22	16	0001 0110	┬	86	56	0101 0110	V	150	96	1001 0110	–	214	D6	1101 0110	Ö
23	17	0001 0111	┤	87	57	0101 0111	W	151	97	1001 0111	—	215	D7	1101 0111	×
24	18	0001 1000	↑	88	58	0101 1000	X	152	98	1001 1000	˜	216	D8	1101 1000	Ø
25	19	0001 1001	├	89	59	0101 1001	Y	153	99	1001 1001	™	217	D9	1101 1001	Ù
26	1A	0001 1010	→	90	5A	0101 1010	Z	154	9A	1001 1010	š	218	DA	1101 1010	Ú
27	1B	0001 1011	←	91	5B	0101 1011	[	155	9B	1001 1011	›	219	DB	1101 1011	Û
28	1C	0001 1100		92	5C	0101 1100	\	156	9C	1001 1100	œ	220	DC	1101 1100	Ü
29	1D	0001 1101		93	5D	0101 1101	]	157	9D	1001 1101		221	DD	1101 1101	Ý
30	1E	0001 1110		94	5E	0101 1110	^	158	9E	1001 1110	ž	222	DE	1101 1110	Þ
31	1F	0001 1111		95	5F	0101 1111	_	159	9F	1001 1111	Ÿ	223	DF	1101 1111	ß
32	20	0010 0000		96	60	0110 0000	`	160	A0	1010 0000		224	E0	1110 0000	à
33	21	0010 0001	!	97	61	0110 0001	a	161	A1	1010 0001	¡	225	E1	1110 0001	á
34	22	0010 0010	"	98	62	0110 0010	b	162	A2	1010 0010	¢	226	E2	1110 0010	â
35	23	0010 0011	#	99	63	0110 0011	c	163	A3	1010 0011	£	227	E3	1110 0011	ã
36	24	0010 0100	$	100	64	0110 0100	d	164	A4	1010 0100	¤	228	E4	1110 0100	ä
37	25	0010 0101	%	101	65	0110 0101	e	165	A5	1010 0101	¥	229	E5	1110 0101	å
38	26	0010 0110	&	102	66	0110 0110	f	166	A6	1010 0110	¦	230	E6	1110 0110	æ
39	27	0010 0111	'	103	67	0110 0111	g	167	A7	1010 0111	§	231	E7	1110 0111	ç
40	28	0010 1000	(	104	68	0110 1000	h	168	A8	1010 1000	¨	232	E8	1110 1000	è
41	29	0010 1001	)	105	69	0110 1001	i	169	A9	1010 1001	©	233	E9	1110 1001	é
42	2A	0010 1010	*	106	6A	0110 1010	j	170	AA	1010 1010	ª	234	EA	1110 1010	ê
43	2B	0010 1011	+	107	6B	0110 1011	k	171	AB	1010 1011	«	235	EB	1110 1011	ë
44	2C	0010 1100	,	108	6C	0110 1100	l	172	AC	1010 1100	¬	236	EC	1110 1100	ì
45	2D	0010 1101	-	109	6D	0110 1101	m	173	AD	1010 1101	-	237	ED	1110 1101	í
46	2E	0010 1110	.	110	6E	0110 1110	n	174	AE	1010 1110	®	238	EE	1110 1110	î
47	2F	0010 1111	/	111	6F	0110 1111	o	175	AF	1010 1111	¯	239	EF	1110 1111	ï
48	30	0011 0000	0	112	70	0111 0000	p	176	B0	1011 0000	°	240	F0	1111 0000	ð
49	31	0011 0001	1	113	71	0111 0001	q	177	B1	1011 0001	±	241	F1	1111 0001	ñ
50	32	0011 0010	2	114	72	0111 0010	r	178	B2	1011 0010	²	242	F2	1111 0010	ò
51	33	0011 0011	3	115	73	0111 0011	s	179	B3	1011 0011	³	243	F3	1111 0011	ó
52	34	0011 0100	4	116	74	0111 0100	t	180	B4	1011 0100	´	244	F4	1111 0100	ô
53	35	0011 0101	5	117	75	0111 0101	u	181	B5	1011 0101	µ	245	F5	1111 0101	õ
54	36	0011 0110	6	118	76	0111 0110	v	182	B6	1011 0110	¶	246	F6	1111 0110	ö
55	37	0011 0111	7	119	77	0111 0111	w	183	B7	1011 0111	·	247	F7	1111 0111	÷
56	38	0011 1000	8	120	78	0111 1000	x	184	B8	1011 1000	¸	248	F8	1111 1000	ø
57	39	0011 1001	9	121	79	0111 1001	y	185	B9	1011 1001	¹	249	F9	1111 1001	ù
58	3A	0011 1010	:	122	7A	0111 1010	z	186	BA	1011 1010	º	250	FA	1111 1010	ú
59	3B	0011 1011	;	123	7B	0111 1011	{	187	BB	1011 1011	»	251	FB	1111 1011	û
60	3C	0011 1100	<	124	7C	0111 1100			188	BC	1011 1100	¼	252	FC	1111 1100	ü
61	3D	0011 1101	=	125	7D	0111 1101	}	189	BD	1011 1101	½	253	FD	1111 1101	ý
62	3E	0011 1110	>	126	7E	0111 1110	~	190	BE	1011 1110	¾	254	FE	1111 1110	þ
63	3F	0011 1111	?	127	7F	0111 1111		191	BF	1011 1111	¿	255	FF	1111 1111	ÿ