

1.

a) Bits =  $\text{ceil}(\log_2(1/P(i)))$

instruction	P(i)	$\log_2(1/P(i))$	Bits
ADD	0.0542	4.2056	5
SUB	0.0274	5.1897	6
BIC	0.0309	5.0162	6
BICB	0.0000	$\infty$	$\infty$
BIS	0.0012	9.7027	10
BISB	0.0013	9.5873	10
CMP	0.0626	3.9977	4
CMPB	0.0212	5.5598	6
BIT	0.0041	7.9302	8
BITB	0.0014	9.4804	10
MOV	0.1517	2.7207	3
MOVB	0.0524	4.2543	5
XOR	0.0000	$\infty$	$\infty$

b) Bits =  $\text{ceil}(\log_2(1/P_c(i)))$ ,  $P_c$  — conditional probability.  
 Source addressing mode:

mode	$P_c(i)$	$\log_2(1/P_c(i))$	Bits
0	0.1377/0.4096	1.5727	2
1	0.0338/0.4096	3.5991	4
2	0.1587/0.4096	1.3679	2
3	0.0122/0.4096	5.0693	6
4	0.0352/0.4096	3.5406	4
5	0.0000/0.4096	$\infty$	$\infty$
6	0.0271/0.4096	3.9179	4
7	0.0022/0.4096	7.5406	8

Destination addressing mode:

mode	$P_c(i)$	$\log_2(1/P_c(i))$	Bits
0	0.3146/0.6872	1.1272	2
1	0.0599/0.6872	3.5201	4
2	0.0854/0.6872	3.0084	4
3	0.0307/0.6872	4.4844	5
4	0.0823/0.6872	3.0618	4
5	0.0000/0.6872	$\infty$	$\infty$
6	0.0547/0.6872	3.6511	4
7	0.0080/0.6872	6.4246	7

c) Based on the first table,  $P(\text{BCBI})$  and  $P(\text{XOR})$  are approximately equal to 0, so they should be omitted from the instruction set.

d) Based on the second and third table,  $P_c(\text{mode } 5)$  is approximately equal

to 0, so it should be omitted from the source and destination addressing mode.

2.

Carry-lookahead adder based on 3-ary tree:

$$P = P_0 \& P_1 \& P_2$$

$$G = G_2 \mid (P_2 \& G_1) \mid (P_2 \& P_1 \& G_0)$$

$$C_1 = (P_0 \& C_0) \mid G_0$$

$$C_2 = C_1 \mid (P_1 \& P_0 \& C_0) \mid (P_1 \& G_1)$$