Department of Electrical Engineering, IIT Bombay EE206 Digital Circuits: Tutorial Sheet I Number Systems and Boolean Algebra: An Introduction

- 1. What are Reflected Gray Codes? Enumerate the first 16.
- 2. (*Mano*, Question 1-6) Convert the following numbers from the given bases to the bases indicated:
 - (a) decimal 225.225 to binary, octal and hexadecimal
 - (b) binary 11010111.110 to decimal, octal and hexadecimal
 - (c) octal 623.77 to decimal, octal and binary
 - (d) hexadecimal 2AC5.D to decimal, octal and binary

Answers:

Decimal	Binary	Octal	Hexadecimal
225.225	11100001.001110011	341.16314	E1.399
215.75	11010111.110	327.6	D7.C
403.9843	110010011.111111	623.77	193.FC
10949.8125	10101011000101.1101	25305.64	2AC5.D

- 3. (*Mano*, Question 2-6) Reduce the following Boolean expressions to the required number of literals:
 - (a) ABC + A'B'C + A'BC + ABC' + A'B'C' to 5 literals
 - (b) BC + AC' + AB + BCD to 4 literals
 - (c) [(CD)' + A']' + A + CD + AB to 3 literals
 - (d) $(A+C+D)(A+C+D)(A+C+D^\prime)(A+C^\prime+D)(A+B^\prime)$ to 4 literals

Answers:

- (a) A'B' + B(A+C)
- (b) BC + AC'
- (c) A + CD
- (d) A + B'CD
- 4. (Mano, Question 2-11) Given the Boolean function F = xy + x'y' + y'z, draw the corresponding circuit implementation (in terms of the corresponding symbols for the gates) with
 - (a) only AND, OR and NOT gates
 - (b) only OR and NOT gates
 - (c) only AND and NOT gates

Partial Answers:

- (a) Obvious !
- (b) F = (x' + y')' + (x + y)' + (y + z')'
- (c) F = [(xy)'(x'y')'(y'z)']'
- 5. (*Mano*, Question 2-13) Express the following functions as a sum of minterms and a product of maxterms:
 - (a) F(A, B, C, D) = D(A' + B) + B'D
 - (b) F(w, x, y, z) = y'z + wxy' + wxz' + w'x'z
 - (c) F(A, B, C, D) = (A' + B' + C)(A + B')(A + C' + D)(A' + B + C + D')(B + C' + D')
 - (d) F(A, B, C) = (A' + B)(B' + C)
 - (e) F(x, y, z) = 1
 - (f) F(x, y, z) = (xy + z)(y + xz)

Answers:

- (a) $\sum (1,3,5,7,9,11,13,15) = \prod (0,2,4,6,8,10,12,14)$
- (b) $\sum (1,3,5,9,12,13,14) = \prod (0,2,4,6,7,8,10,11,15)$
- (c) $\sum (0, 1, 2, 8, 10, 12, 13, 14, 15) = \prod (3, 4, 5, 6, 7, 9, 11)$
- (d) $\sum (0, 1, 3, 7) = \prod (2, 4, 5, 6)$
- (e) $\sum (0, 1, 2, 3, 4, 5, 6, 7)$, no maxterms
- (f) $\sum (3,5,6,7) = \prod (0,1,2,4)$
- 6. (*Mano*, Question 2-22) TTL SSI (Transistor-Transistor Logic, Small-Scale Integration) chips usually come in 14-pin packages. Two pins are reserved for power supply, and the other pins are used for input and output terminals. How many gates are enclosed in one such package if it contains the following types of gates:
 - (a) 2-input X-OR gates
 - (b) 3-input AND gates
 - (c) 4-input NAND gates
 - (d) 5-input NOR gates
 - (e) 8-input NAND gates