11 0 01 10 0 11 00 1 0 00 10 00 00 00 SHEET 6 elementary boolean functions -> and are universal: Hence, we need to show that 1, v and 7 are produced with -> and 7 0010 0001 0000 1001 1111 1001 000 1111 1 (nand) is a universal function.

$$x \rightarrow y = (x \uparrow y) \uparrow (x \uparrow y)$$

$$x \rightarrow y \Rightarrow (x \uparrow y) \uparrow (x \uparrow y)$$

$$x \rightarrow y \Rightarrow (x \rightarrow y) \rightarrow (x \rightarrow y)$$

$$x \rightarrow y = (x \rightarrow y) \rightarrow (x \rightarrow y)$$

$$x \rightarrow y \Rightarrow (x \rightarrow y) \rightarrow (x \rightarrow y)$$

$$x \rightarrow y \Rightarrow (x \rightarrow y) \Rightarrow (x \rightarrow y$$

7	N	ne	truth	table
100		The second		

T			7 X	7 V	X -> "X	Y-> Y	(Y== Y)=	(x, c, x)	XVV
	X	7	1	· In	1010	1	0	0	5
	0	0/10	0 5	_1	20120	7 91	1316/	1	0
	0	1	1	0	1	0	1	1	11
Table Street			0	1	10	_ 1x	0	Alx	11
- Contractor	Fre	0	7	55		n	11	0	1
	1	1	0	0	0	0	-	0	

TIXTX = YAXO

• 7 X = X1X

x -> 7 x is equivalent to 1 -> we can write or using -> and 7

7X=X ->7X 0 0

The truth table 1 (x 1 x) = V V X

	1 X J	JX	X->7X	Yrrax
bo	0	1	11	otan go
	1	0	0	

(VIC-Y) FF (XFC X) = YVX

6.2) [V8VA] 1 () [V (81A) [) = (0.8,A) 0 8 (A,B) = (7A N7B) ~ (7A NB) ~ (A N7B) = (7AV(BN7B) N(AV7B) (distributivity) = (7AVO) \ (AV7B) (complementation) = 7A \ (AV7B) (identity) = (7A AA) v (7AA7B) (distributivity) = 0 v (7A × 7B) (complementation) = 7 A 17 B (identity) MAN A (812 7 (AVB) AT (de Morgan) A 9 b) 4 (A, B, C) = (A 17 B) N (A 1 7 B 1 C) = A N (7B V (7BNC)) (distributivity) = A A TB (obserption) 04(A,B,C,D)=(Av7(BNA)) ~(Cv(DvC)) = (A v 7B v 7A) ~ (c v (c v D)) (commutativity, = (A v 7A v 7B) ~ ((c v C) v D) (associativity, commutativity) = (I v 7B) ~ (C v D) (idempotency, complementation) = 1 ^ (C v D) (domination) = CUD (identity)

d) 9 (A,B,C)=(7(ANB) V7C) ~(7AVB V7C) = (7 AVBUTC) N (7AVBVTC) (de Morgan) = (7AUTCUTB) N (7AUTCUB) (commutativity) = (7AUTC) U (7BNB) (distributivity) = (7AV7C) vo (complementation) = 7 A V 7 CA (identity) = 7 (A rc) (8 (de Morgan) e) $P(A,B) = (A \lor B) \land (\neg A \lor B) \land (A \lor \neg B) \land (\neg A \lor \neg B)$ $= (B \lor (A \land \neg A)) \land (\neg B \lor (A \land \neg A)) \quad (distributivity)$ $= (A \land \neg A) \lor (B \land \neg B) \land (distributivity)$ = 0 v0 (complementation) no= 0 sedo) 8" . A A (O+0) +) = (A + = (B+A)) = (C+ (D+C)) ((av) v) ((A [v 8 [v A) = (00 (00 (00)) M(BEVAFVA)= 12/201057) (1 v) (8 v v) = alterenob) (av) 1

-									-	-			+ +			
6.3	3)										la c	. 10	ipual.	(1PVG) A,	(1p.	4 @ \ ^ (1Q v R) 1 RUS) ^ (15 v P)
P	Q	R	15	٦P	1PVQ	'Q	Jank	rR	1RV5	75	1501	P	1 (10 MR)	(20 18) (18A	5) 1	1 (SYP)
0	0	0	0	-1	18	1	1	3)	1		0 1	+	4			0
0	0	0	1	1	1	1	1	1	1	0	0	-			H	n
0	0	1	0	1	1/1	1	1	0	0	1	1		1	0	-	0
0	1	0	0	1	1	0	0	1	15	1	TV		0	0	1	0
1	0	0	0	0	0	1	1		1	1	111		0	0	16	Ortoble
1	1	0	0	0		0	0	1	TY	1	1		0	0		0
1	0	1	0	0	0	1	1	0	0	1	1		0	0		0
ME	0	0	1	0	0	100	6.4	To e	16	0	THY.	11	0	0		0
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0	0	1	1	1	1	1	1	0	0	0	0		П	0		0
p	1	1	0	0	1 6	0	1	0	0	9	1		11	0		0
1	1	10	1	0	1	0	0	1	1	0	1		0	0		0
1	0		1	0	0	1	1	0	1	0	I		0	0		0

	1 0	1 0 1	0 1 0	9 9
0 11 11 11	1101	11011	0 0 1	
01110	10	1 0 1	0 1 1	0 1
0 1 0 1 1			0 0 0	
a) There are two	rows w	hich result	is 1 cm the	re are two inter-
pretations of the	wariah	e4 D D D	S that sati	sty 4
b) where the re	sult is	1, there	we obtain a	DNF. Row 1 and
b) where the res	4 as t	heir result	is 1. In ord	er to write the
1 1 1		Control of the Contro	AFWAR ICHTON MIC	110900
which are 0 and	then c	ombine the	em with 1.	After mai, we
combine the paren	theses! w	0 V Ativ		9 9
0 0 0 1 1 1			0 0 1	
0 0 NIE 17P	TOATR	(N75) V (PAGARAS)	
		100 K 15 1503	13 DAL 167	(S-1)
			2 2 2 4 6 7 6	1 2 2 4 2 5 4 2 5 4 2 5 4 2 5 4 5 5 4 5 5 5 5