EECE105L Solutions: Tutorial Sheet - 15

1. i) $125_{(10)} = \_\_\_\_\_\__{(2)}$

$$\begin{array}{r|l l}
2 & 125 & \\
2 & 62 & 1 \\
2 & 31 & 0 \\
2 & 15 & 1 \\
2 & 7 & 1 \\
2 & 3 & 1 \\
 & 1 & 1
\end{array}$$

$01111101_{(2)}$

ii) $89_{(10)} = 0101\ 1001_{(2)}$

iii) $24_{(10)} = 0001\ 1000_{(2)}$

iv) $56_{(10)} = 0011\ 1000_{(2)}$

(v) $12.9_{(10)} = \_\_\_\_\_\__{(2)}$

Integer part $12_{(10)} = 1100_{(2)}$

$.9_{(10)}$ multiply with 2 = $1.8 \Rightarrow 0.1$

$.8 \times 2 = 1.6 \Rightarrow 0.01$

$.6 \times 2 = 1.2 \Rightarrow 0.001$

$.2 \times 2 = 0.4 \Rightarrow 0.0000$

$.4 \times 2 = 0.8 \Rightarrow 0.00000$

$.8 \times 2 = 1.6 \Rightarrow 0.000001$

$.6 \times 2 = 1.2 \Rightarrow 0.0000001$

$.2 \times 2 = .4 \Rightarrow 0.00000000$

$.4 \times 2 = .8 \Rightarrow 0.000000000$

$.8 \times 2 = 1.6 \Rightarrow 0.0000000001$

$.9_{(10)} = 0.11100110011100\ldots$

$12.9_{(10)} = 1100.11100110011001100\ldots_{(2)}$

vi) $9.286_{(10)} = 1001.0100100100 11_{(2)}$

vii) $17.987_{(10)} = \underline{10001.11111001010 1}_{(2)}$

2) i) $12_{(10)} = \underline{00001100}_{(2)}$

ii) $38_{(10)} = \underline{0010\ 0110}_{(2)}$

iii) $-189_{(10)} =$ ______

$189 = 1011\ 1101_{(2)}$

As we want signed number, we write

$189_{10} = \underbrace{0000}_{\text{signed bit}}\ 0000\ 1011\ 1101_{(2)}$

2's complement 1111 1111 0100 0010

Add +1 $\qquad\qquad\qquad\qquad 1$

$\underline{1}111\ 1111\ 0100\ 0011_{(2)}$

Sign bit

(iv) $-267_{(10)} = \underline{1}111\ 1110\ 1111\ 0101_{(2)}$

Sign bit

3) (i) $128 + 29 = 1001\ 1101_{(2)}$

(ii) $287 - 128$

$287_{(10)} = 0000\ 0001\ 0001\ 1111_{(2)}$

$-128_{(10)} = 1111\ 1111\ 1000\ 0000_{(2)}$

$\quad 1\ 0000\ 0000\ 1001\ 1111$

1 → ignore over flow

$287_{(10)} - 128_{(10)} = 0000\ 0000\ 1001\ 1111$

iii) $217_{(10)} - 317_{(10)} = $ ______

$217_{(10)} = 0000\ 0000\ 1101\ 1001_{(2)}$

$-317_{(10)} = 1111\ 1110\ 1100\ 0011_{(2)}$

$1111\ 1111\ 1000\ 1100_{(2)}$

iv) $77_{(10)} - 84_{(10)} = $ ______

$77_{(10)} = 0100\ 1101_{(2)}$

$-84_{(10)} = 1010\ 1100_{(2)}$

$1111\ 1001_{(2)}$

(v) $92_{(10)} - 13_{(10)} = $ ______

$92_{(10)} = 0101\ 1100_{(2)}$

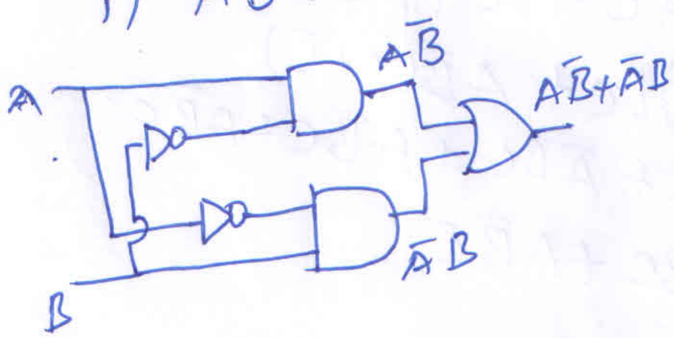
$-13_{(10)} = 1111\ 0011$

$\cancel{1}\ 0100\ 1111_{(2)}$

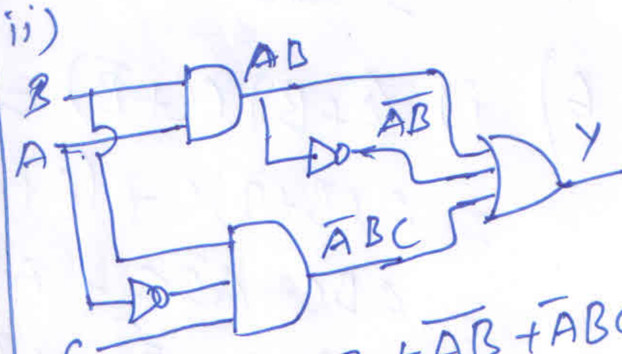
↳ ignore carry

4)

i) $A\bar{B} + \bar{A}B$

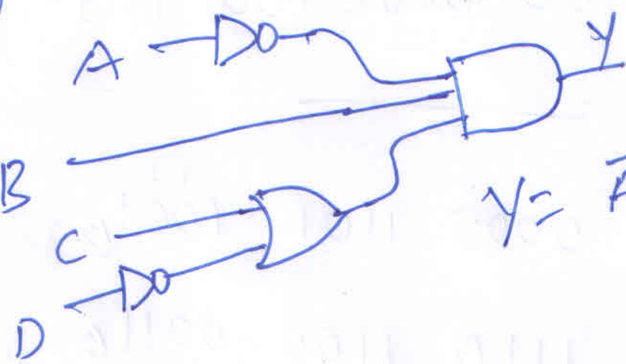


ii)



$Y = AB + \overline{AB} + \bar{A}BC$

iii)



$Y = \bar{A}B(C+\bar{D})$

5)

i) $A\bar{B}C + \bar{A}BC + \bar{A}\bar{B}C = A\bar{B}C + \bar{A}C(B+\bar{B})$

$= C(\bar{A} + A\bar{B})$

$= C(\bar{A}+\bar{B}) = \bar{A}C + \bar{B}C$

ii) $A(\bar{A} + \bar{A}B) = A\bar{A} + A\bar{A}B = A$

iii) $\bar{A}\bar{B}C + \overline{(A+B+\bar{C})} + \bar{A}\bar{B}\bar{C}D$

$= \bar{A}\bar{B}C + \bar{A}\bar{B}C + \bar{A}\bar{B}\bar{C}D$

$= \bar{A}\bar{B}(C+\bar{C}D) = \bar{A}\bar{B}(C+D)$

$= \bar{A}BC + \overline{AB}D$

iv) $(B+BC)(B+\bar{B}C)(B+D)$

$= B(1+C)(B+\bar{B}C)(B+D)$

$= (BB+B\bar{B}C)(B+D) = B(B+D)$

$= BB + BD = B + BD = B(1+D) = \underline{B}$

6) i) $(A+B)(C+\bar{B}) = AC + BC + A\bar{B} + B\bar{B}$

$= A(B+\bar{B})C + (A+\bar{A})BC + A\bar{B}(C+\bar{C})$

$= ABC + A\bar{B}C + ABC + \bar{A}BC + A\bar{B}C + A\bar{B}\bar{C}$

$= ABC + A\bar{B}C + \bar{A}BC + A\bar{B}\bar{C}$

ii) $(C\bar{B}+A)C = C\bar{B}+AC$

$= (A+\bar{A})\bar{B}C + A(B+\bar{B})C$

$= A\bar{B}C + \bar{A}\bar{B}C + ABC + A\bar{B}C$

$= A\bar{B}C + \bar{A}\bar{B}C + ABC$

7)

i) $AB + CD(A\bar{B} + CD) = AB + A\bar{B}CD + CD$

$= AB + CD$

$AB + CD = AB\cdot 1\cdot 1 + 1\cdot 1\cdot CD$

$= AB(C+\bar{C})(D+\bar{D}) + (A+\bar{A})(B+\bar{B})CD$

$= (ABC + AB\bar{C})(D+\bar{D}) + (A+\bar{A})(BCD+\bar{B}CD)$

$= ABCD + AB\bar{C}D + ABC\bar{D} + AB\bar{C}\bar{D} +$

$ABCD + \bar{A}BCD + A\bar{B}CD + \bar{A}\bar{B}CD$

$= ABCD + AB\bar{C}D + ABC\bar{D} + AB\bar{C}\bar{D} +$

$\bar{A}BCD + A\bar{B}CD + \bar{A}\bar{B}CD$

in Each term is evaluated for '1' when $(A=B=C=D=1)$

$1111 + 1101 + 1110 + 1100 +$

$0111 + 1011 + 1100$

The remaining terms will give POS.

The remaining terms are (A, B, C, D) respectively

~~0000 + C0~~

$(A+B+C+D)\cdot(A+B+C+\bar{D})\cdot(A+B+\bar{C}+D)\cdot$

$(A+\bar{B}+C+D)\cdot(\bar{A}+B+C+D)\cdot(A+\bar{B}+\bar{C}+D)\cdot$

$(\bar{A}+B+C+\bar{D})\cdot(A+\bar{B}+C+\bar{D})\cdot(A+\bar{B}+C+\bar{D})$

ii) $AB(\bar{B}\bar{C} + BD) = ABD$

$ABD(C+\bar{C}) = ABCD + AB\bar{C}D$

when, evaluated for "1"

$1111 + 1101$

The POS form is

$(A+B+C+D)(A+B+C+\bar{D})(A+D+\bar{C}+D)\cdot$

$(A+\bar{B}+C+D)(A+\bar{B}+\bar{C}+\bar{D})(\bar{A}+\bar{B}+C+D)\cdot$

$(\bar{A}+B+C+\bar{D})(A+B+\bar{C}+\bar{D})(A+\bar{B}+\bar{C}+D)$

$(\bar{A}+B+\bar{C}+D)(A+\bar{B}+C+\bar{D})(\bar{A}+B+C+D)$

$(A+\bar{B}+C+D)(A+B+C+\bar{D})$

8) i) $A\bar{B} + AC\bar{D}$ (1st figure)

ii) $A\bar{B} + \bar{B}C\bar{D}$ (2nd figure)

iii) $\bar{A}\bar{B}C + A(C\bar{D} + \bar{B}) = \bar{A}\bar{B}C + AC\bar{D} + A\bar{B}$

$+ AC\bar{D} = \bar{B}(A+C) + AC\bar{D}$

$= \bar{B}(A+\bar{A}C) + AC\bar{D}$

$= A\bar{B} + \bar{B}C + ACD$ (3rd fig.)

iv) $A\bar{B} + AC\bar{D} + A\bar{B}C = A\bar{B}(1+C) + AC\bar{D}$

$= A\bar{B} + ACD$ (4th fig.)

9)

(a)

	A	B	C	Y	
POS	0	0	0	0	
	0	0	1	1	SOP
POS	0	1	0	0	
POS	0	1	1	0	
	1	0	0	1	SOP
	1	0	1	1	SOP
POS	1	1	0	0	
	1	1	1	1	SOP

$Y(SOP) = \bar{A}\bar{B}C + A\bar{B}\bar{C} + A\bar{B}C + ABC$

$Y(POS) = (A+B+C)(A+\bar{B}+C)(A+\bar{B}+\bar{C}).(\bar{A}+\bar{B}+C)$

b)

	A	B	C	Y	
POS	0	0	0	0	
POS	0	0	1	0	
POS	0	1	0	0	
POS	0	1	1	0	
POS	1	0	0	0	
	1	0	1	1	SOP
	1	1	0	1	SOP
	1	1	1	1	SOP

$Y_{sop} = AB\bar{C} + A\bar{B}C + ABC$

$Y_{pos} = (A+B+C)(A+B+\bar{C}).(A+\bar{B}+C)(A+\bar{B}+\bar{C}).(\bar{A}+B+C)$