EE 2729, Spr. 2011

Homework #5 solution

<u>Note</u>: Here in this homework I will denote minterm i by $\underline{m_i}$ and maxterm i by $\underline{M_i}$

<u>Problem 1</u>:

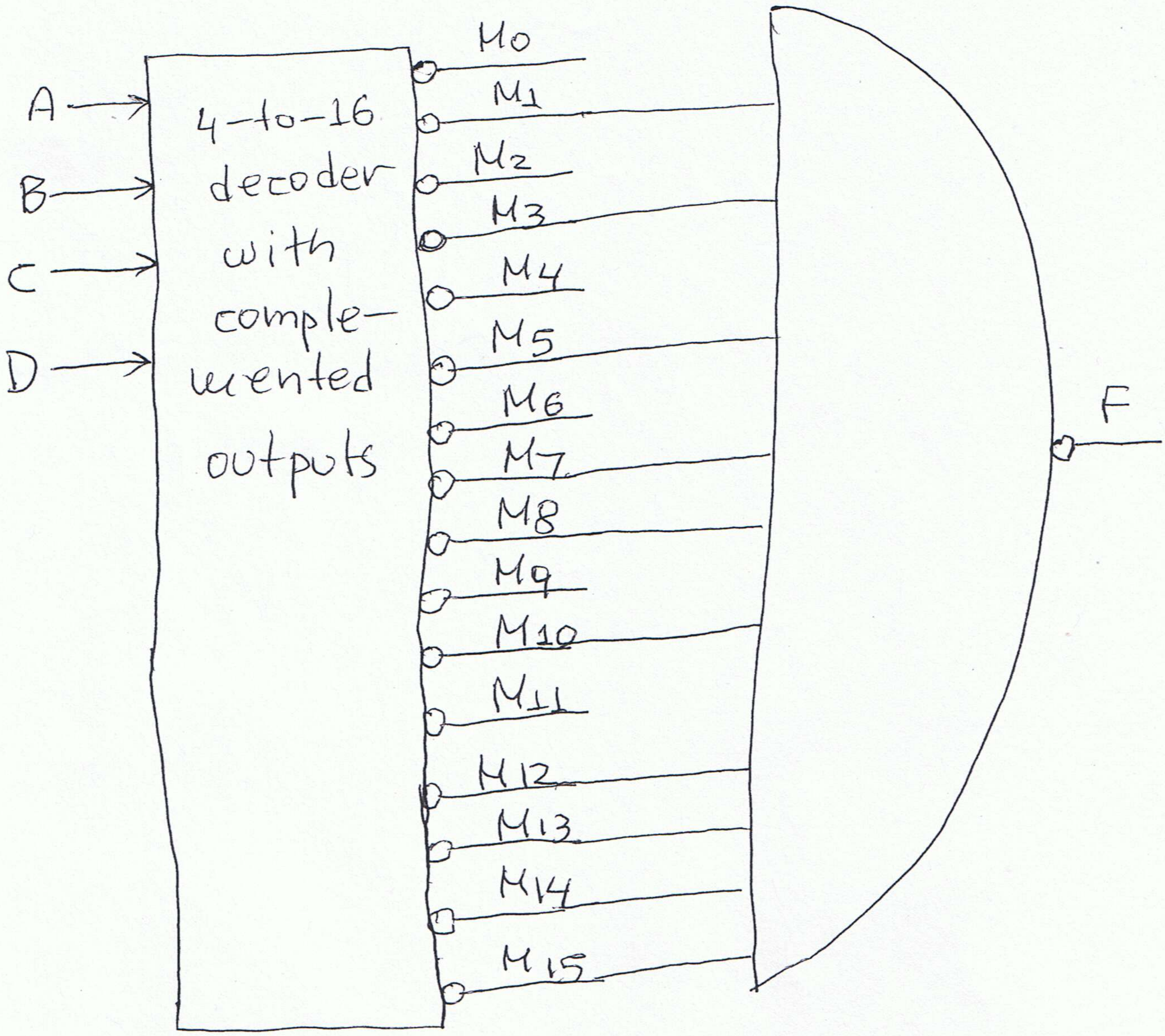
a) we have

$$F = \Sigma_{A,B,C,D}(1,3,5,7,8,10,12,13,14,15)$$
$$= m_1 + m_3 + m_5 + m_7 + m_8 + m_{10} + m_{12} + m_{13} + m_{14} + m_{15}$$
$$= (m_1' \cdot m_3' \cdot m_5' \cdot m_7' \cdot m_8' \cdot m_{10}' \cdot m_{12}' \cdot m_{13}' \cdot m_{14}' \cdot m_{15}')'$$
$$= (M_1 \cdot M_3 \cdot M_5 \cdot M_7 \cdot M_8 \cdot M_{10} \cdot M_{12} \cdot M_{13} \cdot M_{14} \cdot M_{15})'$$

From the above we get the figure shown on the next page

next page

Pr. 1 (a) cont:



(b) We have

$$F = \Sigma_{A,B,C,D}(1,3,5,7,8,10,12,13,14,15)$$

$$= \Pi_{A,B,C,D}(0,2,4,6,9,11).$$ From this we get the figure shown on the next page

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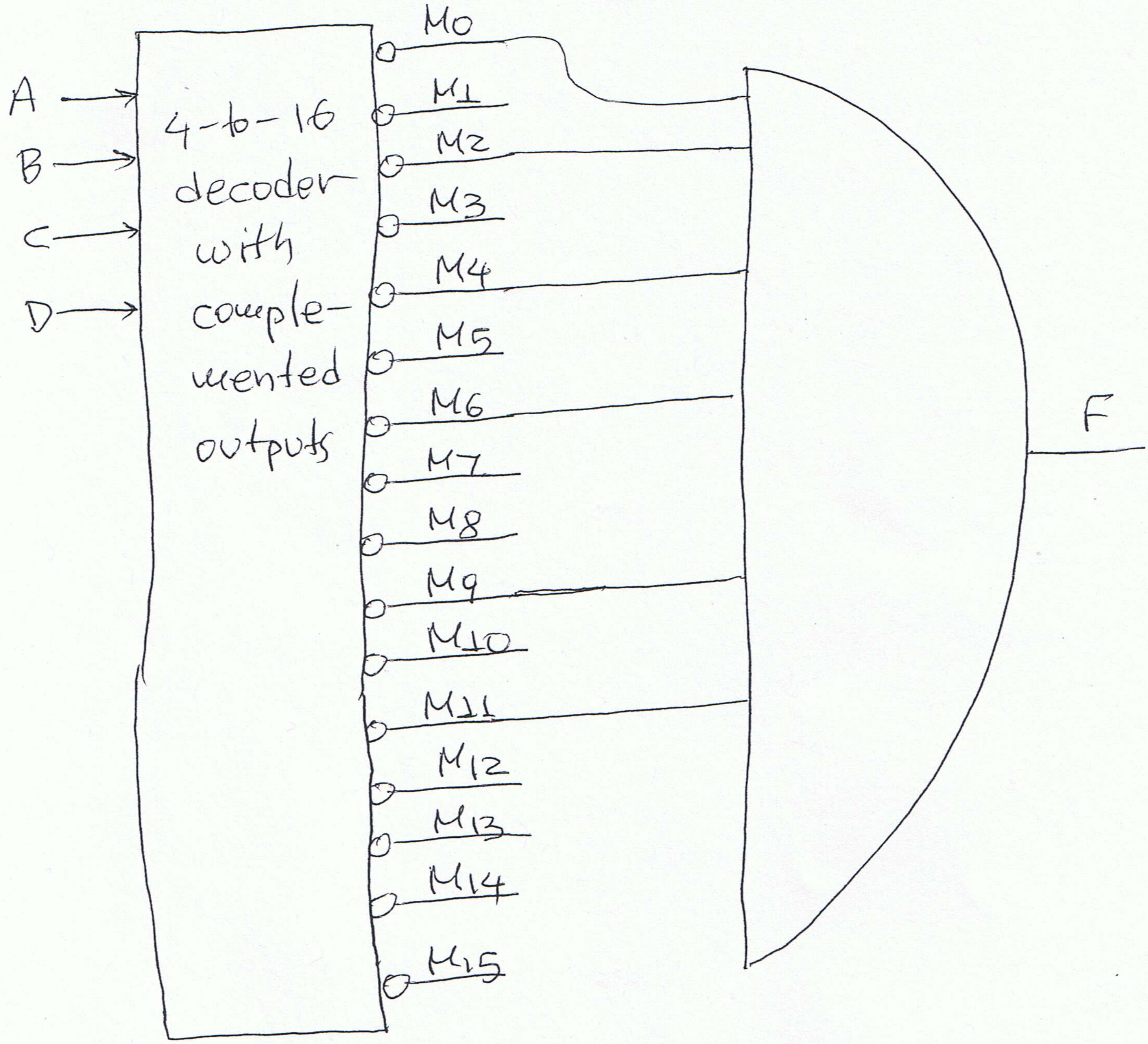
EE 2720, HW#5 sol. cont. 3

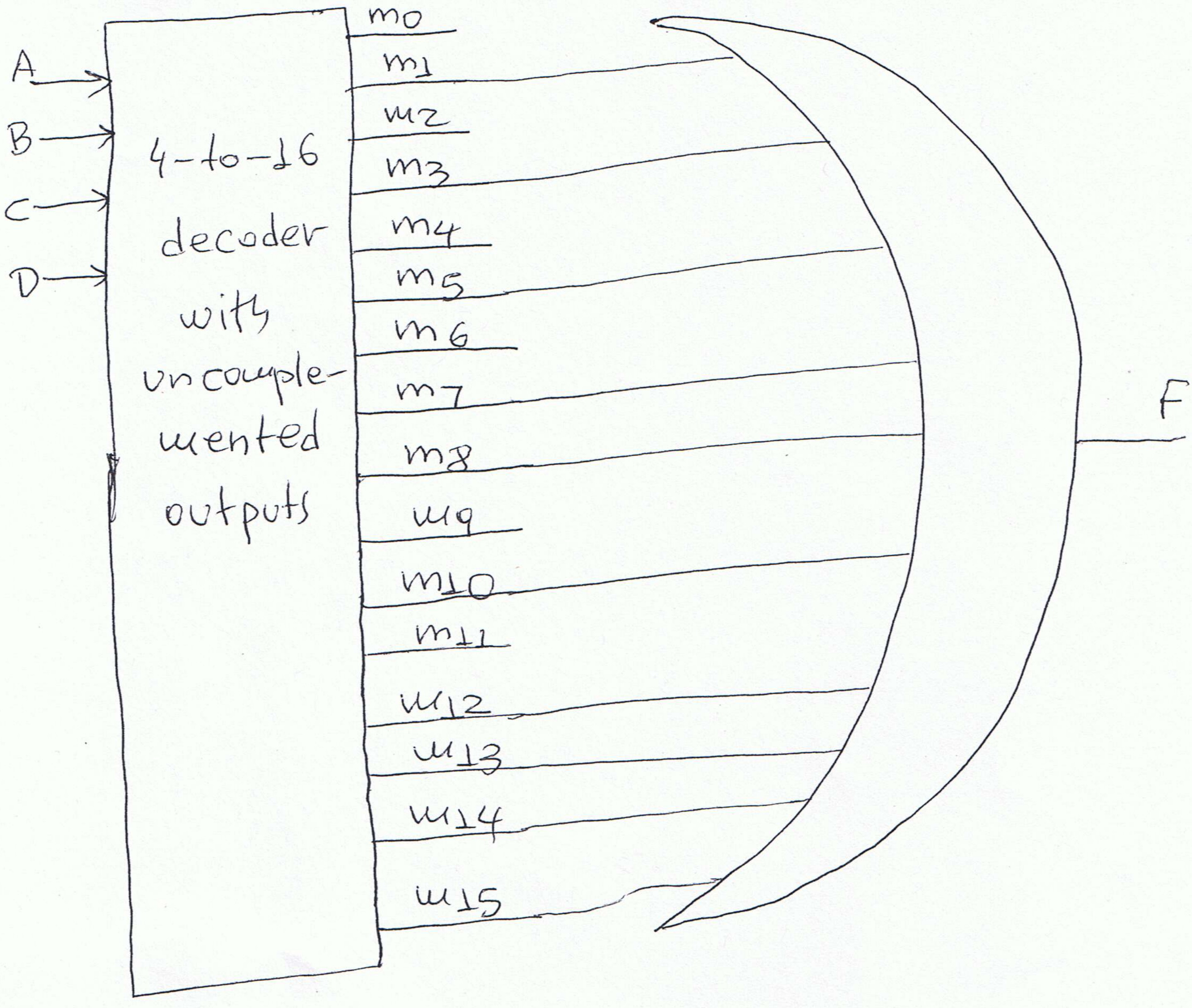
Pr. 1 (b) cont:



(c) We have

$F = \Sigma_{A,B,C,D}(1, 3, 5, 7, 8, 10, 12, 13, 14, 15)$.

From the above we get the figure shown below



d) we have

$$F = \prod_{A,B,C,D}(0, 2, 4, 6, 9, 11)$$

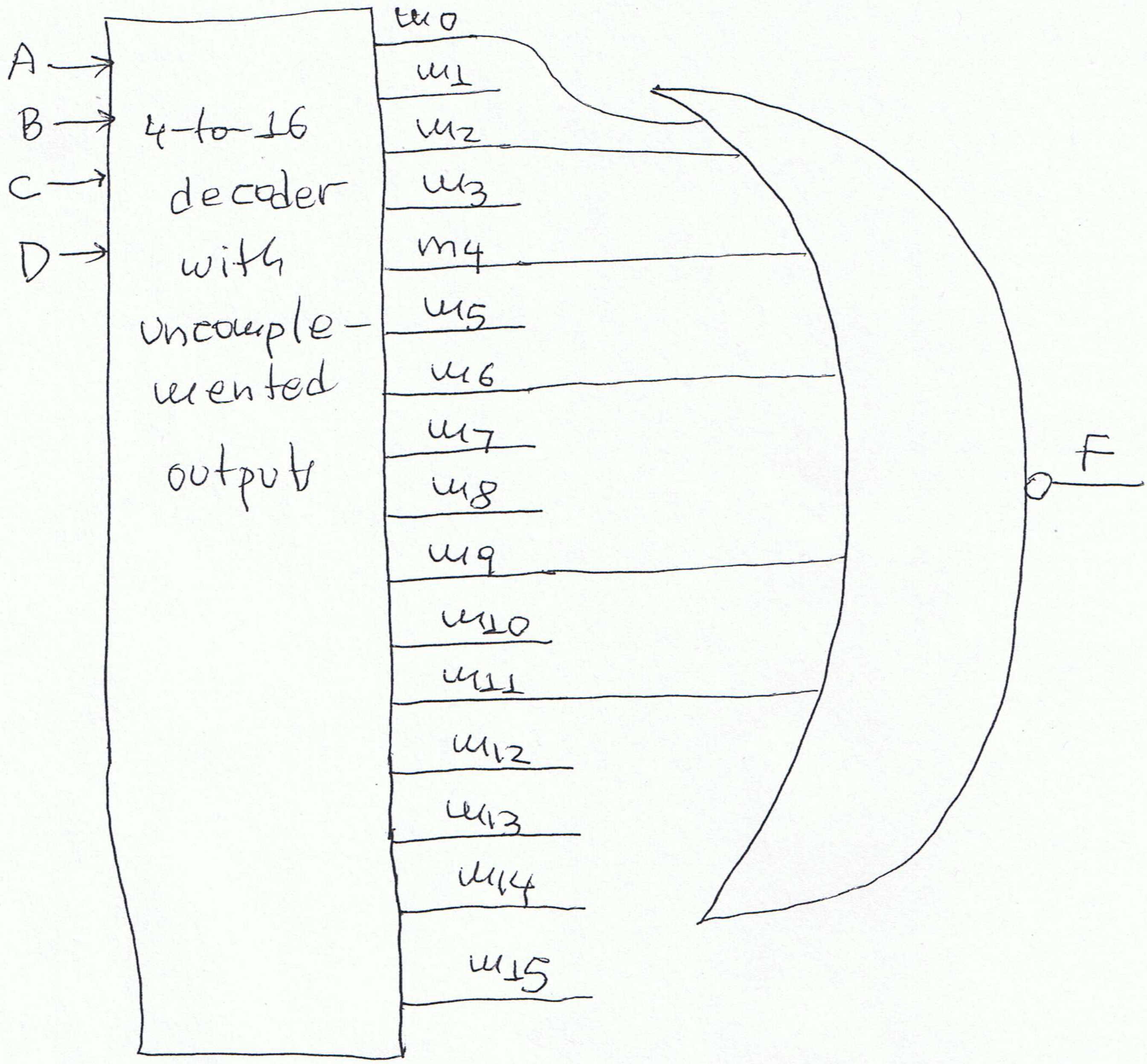
$$= M_0 \cdot M_2 \cdot M_4 \cdot M_6 \cdot M_9 \cdot M_{11}$$

$$= (M_0' + M_2' + M_4' + M_6' + M_9' + M_{11}')'$$

$$= (m_0 + m_2 + m_4 + m_6 + m_9 + m_{11})'$$

From the above we get the figure shown on the next page.

Pr. 1 d cont:


A
B
C
D
4-to-16
decoder
with
uncomple-
mented
output
m0
m1
m2
m3
m4
m5
m6
m7
m8
m9
m10
m11
m12
m13
m14
m15
F

Problem 2: Since a decoder with uncomplemented outputs generates the minterms, we have to express F as a canonical sum. Since F is given as a product-of-sums expression, it is easier to obtain the canonical product from which we can easily get the canonical sum. We have:

$$F = (A+B'+C)\cdot(B'+C+D')\cdot(A'+C+D) =$$

$$(A+B'+C+D\cdot D')\cdot(B'+C+D'+A\cdot A')\cdot(A'+C+D+B\cdot B')$$

$$= (A+B'+C+D)\cdot(A+B'+C+D')\cdot$$
$$(B'+C+D'+A)\cdot(B'+C+D'+A')\cdot$$
$$(A'+C+D+B)\cdot(A'+C+D+B') =$$

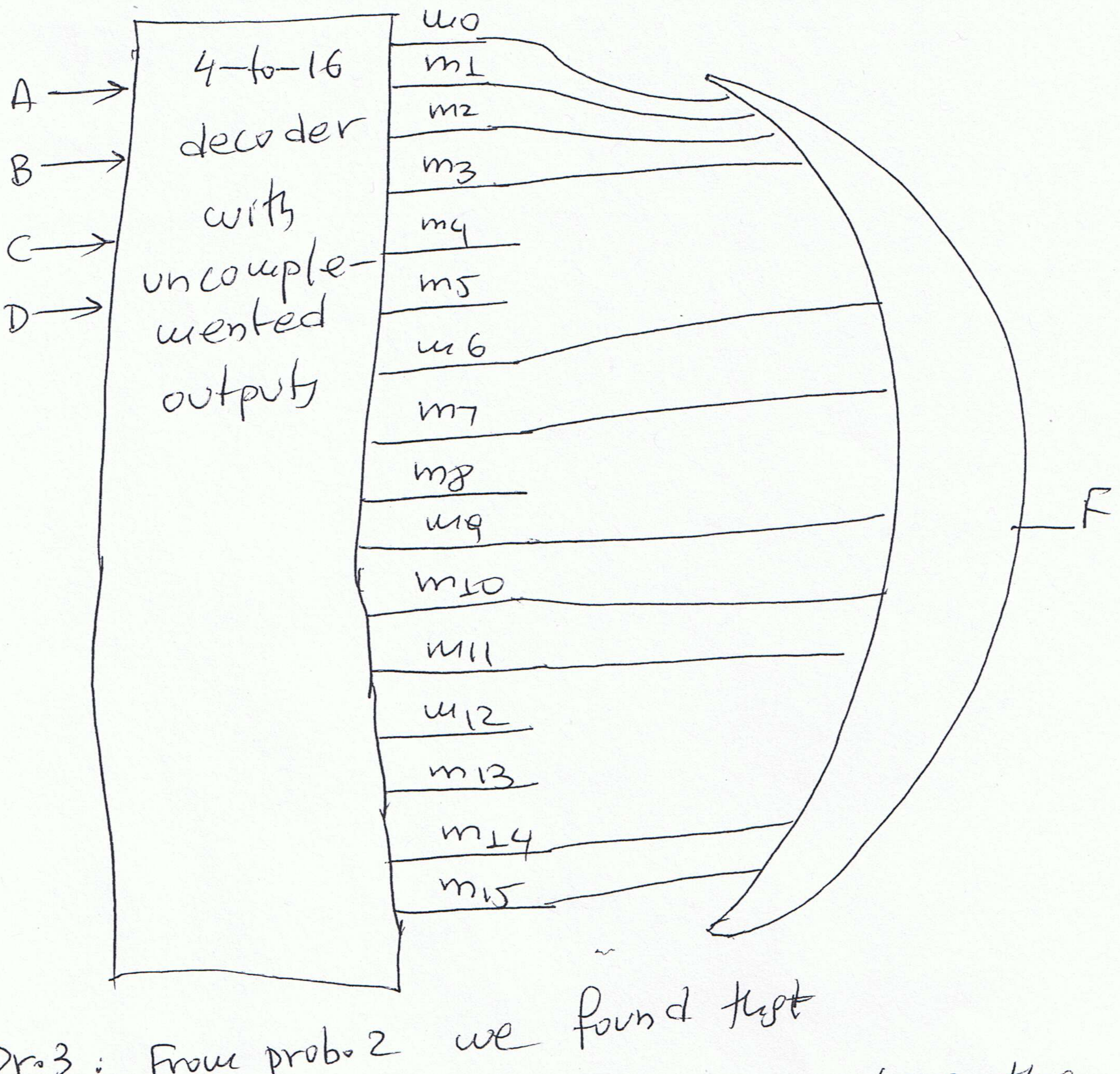
$$\cancel{(A'+B+C+D)\cdot(A'+B'+C+D')}$$

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

$$(\underset{0}{A}+\underset{1}{B'}+\underset{0}{C}+\underset{0}{D})\cdot(\underset{0}{A}+\underset{1}{B'}+\underset{0}{C}+\underset{1}{D'})\cdot$$
$$\cancel{(\underset{0}{A}+\underset{1}{B'}+\underset{0}{C}+\underset{1}{D'})}\cdot(\underset{1}{A'}+\underset{1}{B'}+\underset{0}{C}+\underset{1}{D'})$$
$$(\underset{1}{A'}+\underset{0}{B}+\underset{0}{C}+\underset{0}{D})(\underset{1}{A'}+\underset{1}{B'}+\underset{0}{C}+\underset{0}{D}) =$$

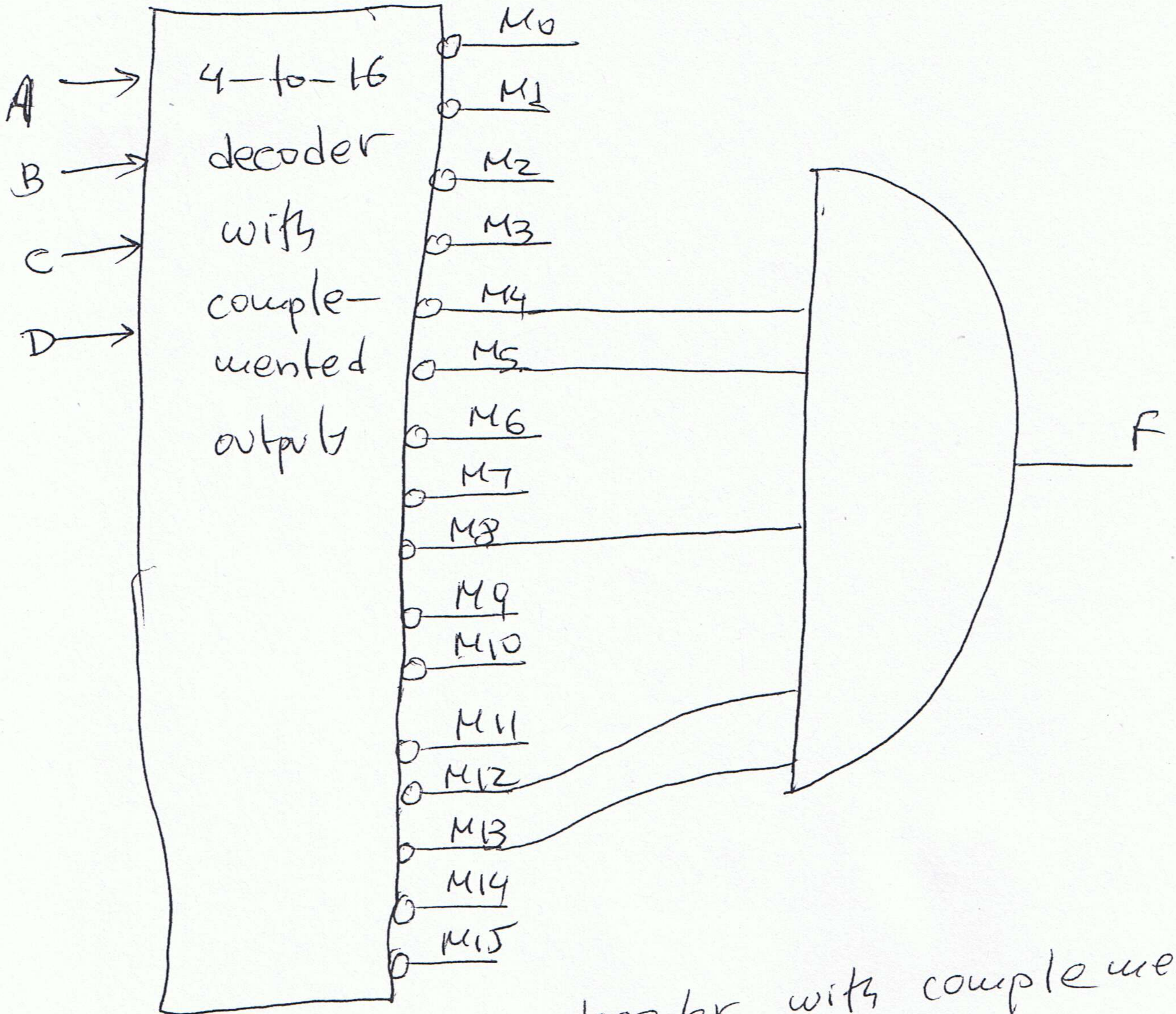
Prob. 2 cont $\prod_{A,B,C,D}(4,5,8,12,13)$

$=\sum_{A,B,C,D}(0,1,2,3,6,7,9,10,11,14,15)$. We now have



Pr. 3: From prob. 2 we found that $F=\prod_{A,B,C,D}(4,5,8,12,13)$. We thus have the figure of the next page

Pro 3 cont.:



Problem 4: Since a decoder with complemented outputs generates the maxterms, we have to express F as a canonical product. Since F is given as sum-of-products, it is ~~easi~~ easier to obtain the canonical sum from which we can easily find the canonical product. We have:

$$F = A\cdot B'\cdot C + B'\cdot C\cdot D' + A'\cdot C\cdot D$$

$$= A\cdot B'\cdot C\cdot(D+D') + B'\cdot C\cdot D'\cdot(A+A') +$$

$$A'\cdot C\cdot D\cdot(B+B') =$$

$$A\cdot B'\cdot C\cdot D + A\cdot B'\cdot C\cdot D'$$

$$+ B'\cdot C\cdot D'\cdot A + B'\cdot C\cdot D'\cdot A'$$

$$+ A'\cdot C\cdot D\cdot B + A'\cdot C\cdot D\cdot B'$$

$$= \underset{1\ 0\ 1\ 1}{A\cdot B'\cdot C\cdot D} + \cancel{\underset{1\ 0\ 1\ 0}{A\cdot B'\cdot C\cdot D'}}$$

$$+ \underset{1\ 0\ 1\ 0}{A\cdot B'\cdot C\cdot D'} + \underset{0\ 0\ 1\ 0}{A'\cdot B'\cdot C\cdot D'}$$

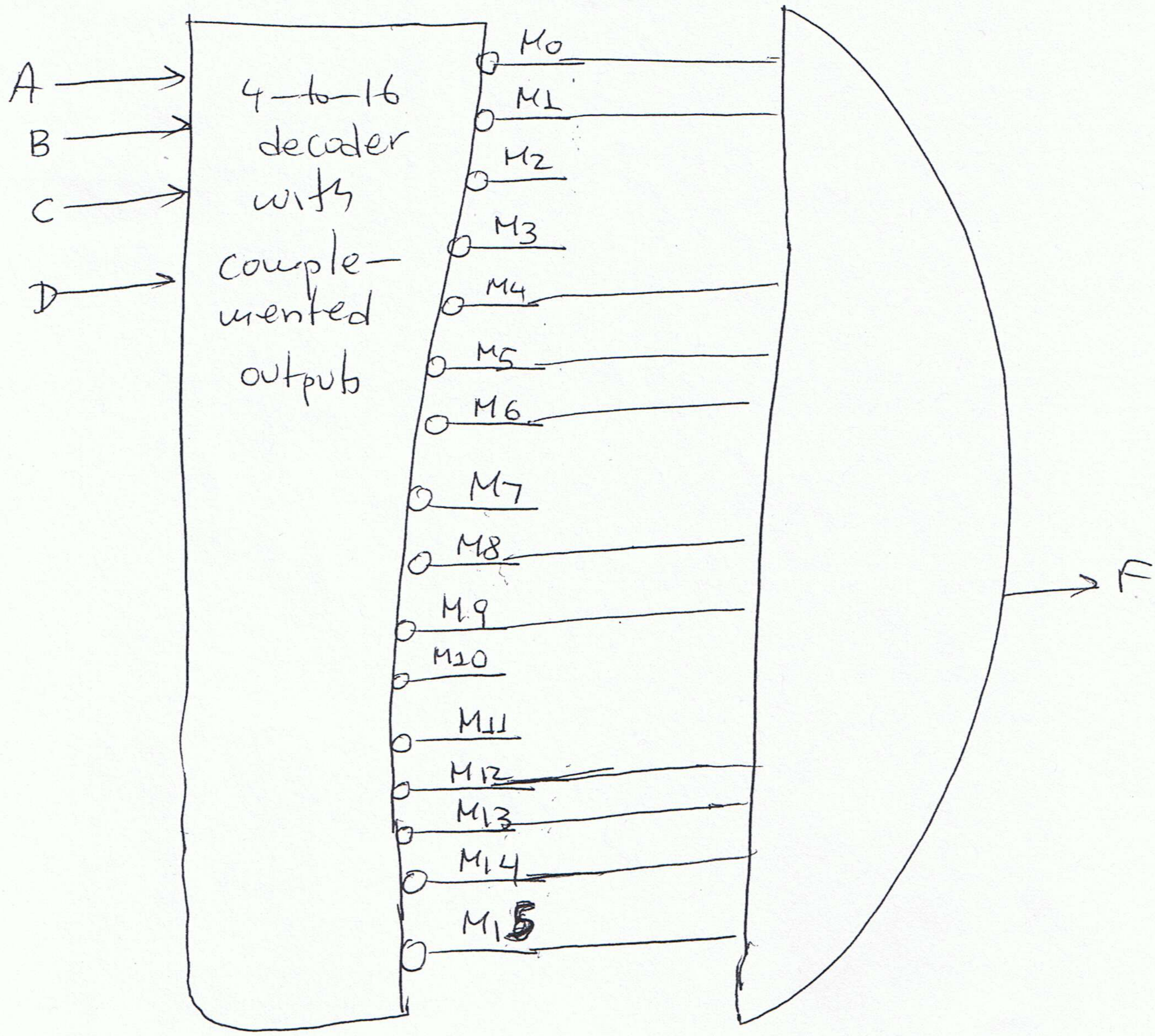
$$+ \underset{0\ 1\ 1\ 1}{A'\cdot B\cdot C\cdot D} + \underset{0\ 0\ 1\ 1}{A'\cdot B'\cdot C\cdot D}$$

$$\cancel{+ A'\cdot B\cdot C\cdot D + A'\cdot B'\cdot C\cdot D}$$

$$= \Sigma_{A,B,C,D}(2, 3, 7, 10, 11)$$

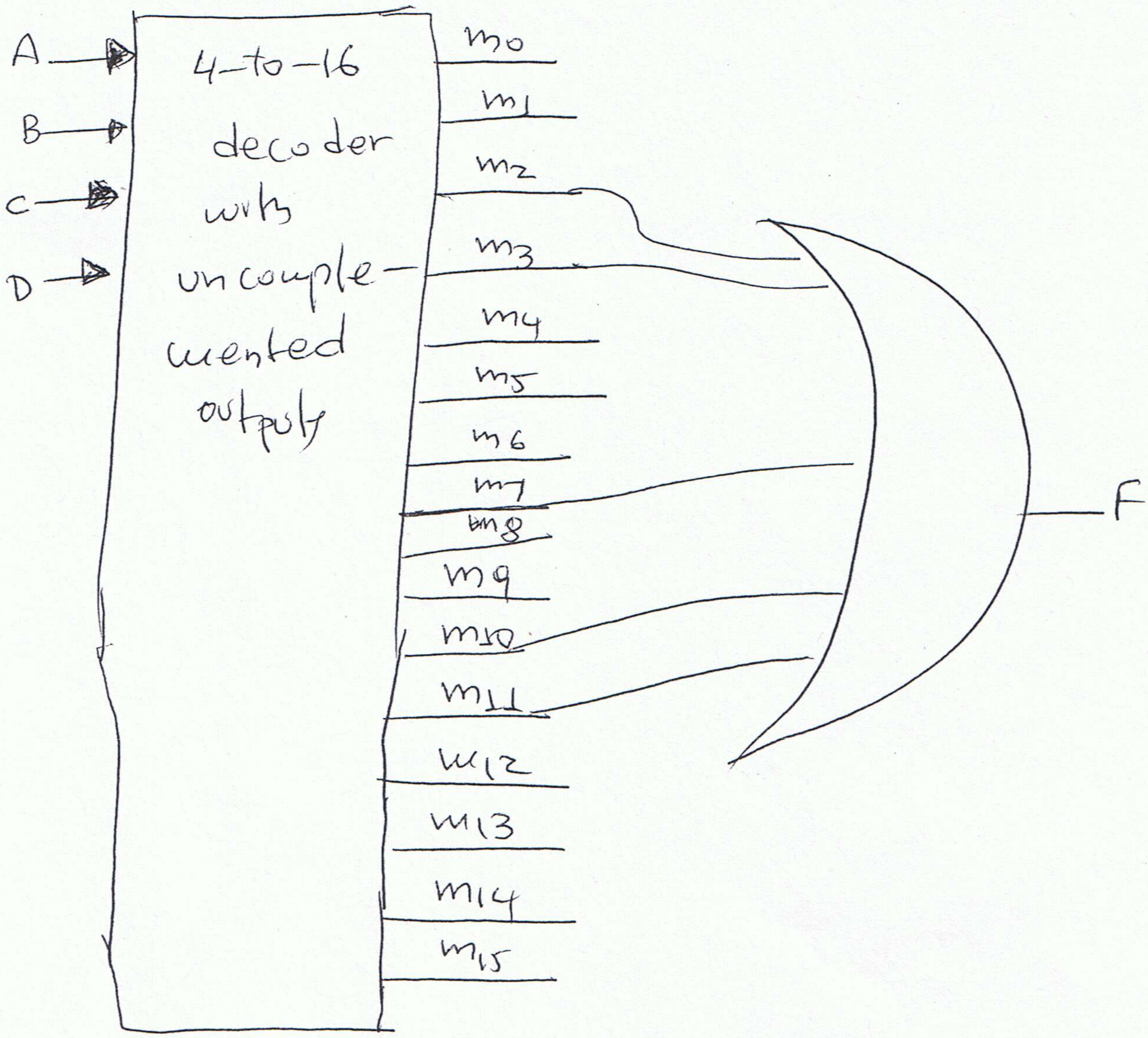
$$= \Pi_{A,B,C,D}(0, 1, 4, 5, 6, 8, 9, 12, 13, 14, 15)$$

From the above we get the figure shown on next page



Problem 5: From problem 4 we found out that $F = \Sigma_{A,B,C,D}(2,3,7,10,11)$

Therefore, we have the figure shown on the next page


A
B
C
D
4-to-16
decoder
with
uncomple-
mented
outputs
m0
m1
m2
m3
m4
m5
m6
m7
m8
m9
m10
m11
m12
m13
m14
m15
F