ICS 2020 Problem Sheet #7

Problem 7.1:

a)

$\phi(A, B, C, D, E) = m_0+m_2+m_4+m_6+m_9+m_{10}+m_{13}+m_{14}+m_{15}+m_{16}+m_{17}+m_{21}+m_{26}+m_{28}+m_{30}+m_{31}$

Classify and sort minterms and processing the combination steps

Minterm	Pattern	Used	Minterm	Pattern	Used	Minterm	Pattern	Used
m_0	00000	x	$m_{0,2}$	000-0	x	$m_{0,2,4,6}$	00--0	
			$m_{0,4}$	00-00	x			
			$m_{0,16}$	-0000				
m_2	00010	x	$m_{2,6}$	00-10	x	$m_{2,6,10,14}$	00--0	
m_4	00100	x	$m_{2,10}$	0-010	x			
m_{16}	10000	x	$m_{4,6}$	001-0	x			
			$m_{16,17}$	1000-				
m_6	00110	x	$m_{6,14}$	0-110	x	$m_{10,26,14,30}$	-1-10	
m_9	01001	x	$m_{9,13}$	01-01				
m_{10}	01010	x	$m_{10,26}$	-1010	x			
m_{17}	10001	x	$m_{10,14}$	01-10	x			
			$m_{17,21}$	10-01				
m_{13}	01101	x	$m_{13,15}$	011-1		$m_{14,15,30,31}$	-111-	
m_{14}	01110	x	$m_{14,15}$	0111-	x			
m_{21}	10101	x	$m_{14,30}$	-1110	x			
m_{26}	11010	x	$m_{26,30}$	11-10	x			
m_{28}	11100	x	$m_{28,30}$	111-0				
m_{15}	01111	x	$m_{15,31}$	-1111	x			
m_{30}	11110	x	$m_{30,31}$	1111-	x			
m_{31}	11111							

we obtain the following prime implicants:

$m_{0,16}$ = ($\neg B \wedge \neg C \wedge \neg D \wedge \neg E$)

$m_{16,17}$ = ($A \wedge \neg B \wedge \neg C \wedge \neg D$)

$m_{9,13}$ =($\neg A \wedge B \wedge \neg D \wedge E$)

$m_{17,21}$ =($A \wedge \neg B \wedge \neg D \wedge E$)

$m_{13,15}$ =($\neg A \wedge B \wedge C \wedge E$)

$m_{28,30}$ =($A \wedge B \wedge C \wedge \neg E$)

$m_{0,2,4,6}$ = ($\neg A \wedge \neg B \wedge \neg E$)

$m_{2,6,10,14}$ =($\neg A \wedge D \wedge \neg E$)

$m_{10,26,14,30}$ =($B \wedge D \wedge \neg E$)

$m_{14,15,30,31}$ =($B \wedge C \wedge D$)

b)

	m0	m2	m4	m6	m9	m10	m13	m14	m15	m16	m17	m21	m26	m28	m30	m31
$m_{0,16}$	x									x						
$m_{16,17}$										x	x					
$m_{9,13}$					x		x									
$m_{17,21}$											x	x				
$m_{13,15}$							x		x							
$m_{28,30}$														x	x	
$m_{0,2,4,6}$	x	x	x	x												
$m_{2,6,10,14}$		x		x		x		x								
$m_{10,26,14,30}$						x		x					x		x	
$m_{14,15,30,31}$								x	x						x	x

$(\neg A \wedge \neg B \wedge \neg C \wedge \neg D \wedge \neg E)$
m_4 is only present in : $m_{0,2,4,6} = (\neg A \wedge \neg B \wedge \neg E)$
m_9 is only present in : $m_{9,13} =(\neg A \wedge B \wedge \neg D \wedge E)$
m_{21} is only present in : $m_{17,21} =(A \wedge \neg B \wedge \neg D \wedge E)$
m_{26} is only present in : $m_{10,26,14,30}=(B \wedge D \wedge \neg E)$
m_{28} is only present in : $m_{28,30}=(A \wedge B \wedge C \wedge \neg E)$
m_{31} is only present in : $m_{14,15,30,31}=(B \wedge C \wedge D)$
The other minterms can be represented by $m_{16,17}=(A \wedge \neg B \wedge \neg C \wedge \neg D)$
therefore the prime implicants are :$m_{0,2,4,6}$, $m_{9,13}$, $m_{17,21}$, $m_{10,26,14,30}$, $m_{28,30}$, $m_{14,15,30,31}$ and $m_{16,17}$.

c)the minimal boolean expression defining ϕ is :

$\phi(A, B, C, D, E) =(\neg A \wedge \neg B \wedge \neg E) \vee (\neg A \wedge B \wedge \neg D \wedge E) \vee (A \wedge \neg B \wedge \neg D \wedge E) \vee$
$(B \wedge D \wedge \neg E) \vee (A \wedge B \wedge C \wedge \neg E) \vee (B \wedge C \wedge D) \vee (A \wedge \neg B \wedge \neg C \wedge \neg D)$