**Homework 3**

**Part 1**

**Question 1: *F* (*A, B, C, D*) =∑*m*(0*,* 1*,* 2*,* 4*,* 5*,* 7*,* 11*,* 15)**

1. **Find all the essential prime implicants and indicate why each one is essential.**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| AB\CD | 00 | 01 | 11 | 10 |
| 00 | 1 0 | 1 1 | 0 3 | 1 2 |
| 01 | 1 4 | 1 5 | 1 7 | 0 6 |
| 11 | 0 12 | 0 13 | 1 15 | 0 14 |
| 10 | 0 8 | 0 9 | 1 11 | 0 10 |

E.P.I. at positions 0,1,4,5 as it is the only P.I. that covers 1,4  
E.P.I. at positions 0,2 as it is the only P.I. that covers 2  
E.P.I. at positions 11,15 as it is the only P.I. that covers 11

1. **Find all the possible minimum sum of product expressions for F.**

F(A,B,C,D)=A’C’+A’B’D’+ACD+A’BD  
F(A,B,C,D)=A’C’+A’B’D’+ACD+BCD

**Question 2: *F* (*A, B, C, D*) =∑*m*(0*,* 1*,* 4*,* 6*,* 7*,* 9*,* 11*,* 13*,* 14) +∑*d*(2*,* 5*,* 12)**

1. **Find all the essential prime implicants and indicate why each one is essential.**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| AB\CD | 00 | 01 | 11 | 10 |
| 00 | 1 0 | 1 1 | 0 3 | x 2 |
| 01 | 1 4 | x 5 | 1 7 | 1 6 |
| 11 | x 12 | 1 13 | 0 15 | 1 14 |
| 10 | 0 8 | 1 9 | 1 11 | 0 10 |

E.P.I. at positions 1,5,9,13 as it is the only P.I. covering 13  
E.P.I. at positions 9,11 as it is the only P.I. that covers 11  
E.P.I. at positions 4,5,6,7 as it is the only P.I. that covers 7

1. **Find all the possible minimum sum of product expressions for F.**

F(A,B,C,D)=C’D+A’B+AB’D+BD’+A’C’  
F(A,B,C,D)=C’D+A’B+AB’D+BD’+A’D’

**Part 2**

**Question 1: Problem 3.2 (f) Simplify using 3-var maps**

**f. F(x,y,z)= ∑m(3,4,5,6,7)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| X\YZ | 00 | 01 | 11 | 10 |
| 0 | 0 0 | 0 1 | 1 3 | 0 2 |
| 1 | 1 4 | 1 5 | 1 7 | 1 6 |

Groups: (3,7),(4,5,6,7)  
 F(x,y,z)=x+yz

**Question 2. Problem 3.4 (f) Simplify using Karnaugh maps**

**f. F(w,x,y,z)= ∑m(8,10,12,13,14)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| WX\YZ | 00 | 01 | 11 | 10 |
| 00 | 0 0 | 0 1 | 0 3 | 0 2 |
| 01 | 0 4 | 0 5 | 0 7 | 0 6 |
| 11 | 1 12 | 1 13 | 0 15 | 1 14 |
| 10 | 1 8 | 0 9 | 0 11 | 1 10 |

Groups: (8,10,12,14),(12,13)  
 F(w,x,y,z)=wz’+wxy’

**Question 3. Problem 3.5 (c) Simplify using 4-var maps**

**c. F(w,x,y,z)= ∑m(1,3,4,5,6,7,9,11,13,15)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| WX\YZ | 00 | 01 | 11 | 10 |
| 00 | 0 0 | 1 1 | 1 3 | 0 2 |
| 01 | 1 4 | 1 5 | 1 7 | 1 6 |
| 11 | 0 12 | 1 13 | 1 15 | 0 14 |
| 10 | 0 8 | 1 9 | 1 11 | 0 10 |

Groups: (1,3,5,7,9,11,13,15),(4,5,6,7)  
 F(w,x,y,z)=z+w’x

**Question 4. Problem 3.6.(c) and (d) Simplify using 4-var maps**

**c. A’BCD+ABC+CD+B’D**

A’BCD+ABC(D+D’)+CD(A+A’)(B+B’)+B’D(A+A’)(C+C’)

=A’BCD+ABCD+ABCD’+ABCD+AB’CD+A’BCD+A’B’CD+AB’CD+AB’C’D+A’B’CD+A’B’C’D

=A’BCD+ABCD+ABCD’+AB’CD+A’B’CD+AB’C’D+A’B’C’D **using Idempotent Law**

=∑m(1,3,7,9,11,14,15)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| AB\CD | 00 | 01 | 11 | 10 |
| 00 | x 0 | 1 1 | 1 3 | 0 2 |
| 01 | 0 4 | 0 5 | 1 7 | 0 6 |
| 11 | 0 12 | 0 13 | 1 15 | 1 14 |
| 10 | 0 8 | 1 9 | 1 11 | 0 10 |

Groups: (1,3,9,11),(3,7,11,15),(14,15)  
 F=B’D+CD+ABC

**d. A’B’C’D’+BC’D+A’C’D+A’BCD+ACD’**

A’B’C’D’+BC’D(A+A’)+A’C’D(B+B’)+A’BCD+ACD’(B+B’)

=A’B’C’D’+ABC’D+A’BC’D+A’BC’D+A’B’C’D+A’BCD+ABCD’+AB’CD’

=A’B’C’D’+ABC’D+A’BC’D+A’B’C’D+A’BCD+ABCD’+AB’CD’ **using Idempotent Law**

=∑m(0,1,5,7,10,13,14)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| AB\CD | 00 | 01 | 11 | 10 |
| 00 | 0 0 | 1 1 | 0 3 | 0 2 |
| 01 | 0 4 | 1 5 | 1 7 | 0 6 |
| 11 | 0 12 | 1 13 | 0 15 | 1 14 |
| 10 | 0 8 | 0 9 | 0 11 | 1 10 |

Groups: (0,1),(5,7),(10,14),(5,13)  
 F=A’B’C’+A’BD+ACD’+BC’D

**Question 5. Problem 3.11 Convert from SOP to simplified POS expression**

**F(w,x,y,z)= ∑m(0,1,3,5,7,9,10,13,15)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| WX\YZ | 00 | 01 | 11 | 10 |
| 00 | 1 0 | 1 1 | 1 3 | 0 2 |
| 01 | 0 4 | 1 5 | 1 7 | 0 6 |
| 11 | 0 12 | 1 13 | 1 15 | 0 14 |
| 10 | 0 8 | 1 9 | 0 11 | 1 10 |

Groups: (2,6),(4,6,12,14),(8,12),(11)  
 F(w,x,y,z)=(w+y’+z)(x’+z)(w’+y+z)(w’+x+y’+z’)

**Question 6. Problem 3.15 (c) Simplify together with the don’t-care conditions and express simplified function in sum-of-minterms form**

**c. F(A,B,C,D)= ∑m(5,6,7,11,14,15)  
 d(A,B,C,D)= ∑d(3,9,13)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| AB\CD | 00 | 01 | 11 | 10 |
| 00 | 0 0 | 0 1 | x 3 | 0 2 |
| 01 | 0 4 | 1 5 | 1 7 | 1 6 |
| 11 | 0 12 | x 13 | 1 15 | 1 14 |
| 10 | 0 8 | x 9 | 1 11 | 0 10 |

Groups: (3,7,11,15),(5,7,13,15),(6,7,14,15)  
F(w,x,y,z)=CD+BD+BC