Quiz 1

CS 3853

July 17, 2024

Name (please print):	
Student ID:	
Total points: 30	

1. (6 points) A compiler developer is trying to compare the designs of three machines with their respective CPIs for several instruction categories. All machines have the same instruction set.

Instruction Category	CPI_A	CPI_{B}	CPI_C	Mix
Load/Store	12	11	9	10%
Subtract	8	7	5.6	20%
Jump	5	4	7	12%
Branch	9	7	12	43%
Shift	6	5	9	30%
Other	22	12	17	50%

• Calculate the average CPI for each machine

Solution: 2 points for each

```
Average CPI_A = (12 \times 0.10) + (8 \times 0.20) + (5 \times 0.12) + (9 \times 0.43) + (6 \times 0.30) + (22 \times 0.50) = 20.07

Average CPI_B = (11 \times 0.10) + (7 \times 0.20) + (4 \times 0.12) + (7 \times 0.43) + (5 \times 0.30) + (12 \times 0.50) = 13.49

Average CPI_C = (9 \times 0.10) + (5.6 \times 0.20) + (7 \times 0.12) + (12 \times 0.43) + (9 \times 0.30) + (17 \times 0.50) = 19.22
```

2. (4 points) Show the truth table for the following function

$$F(A, B, C) = \overline{A}\,\overline{B} + \overline{A}C + \overline{B}\,\overline{C}$$

Can you find a simpler expression for F? If yes, please show it.

Solution: 4 points - 3 points for the truth table, 1 point for any reasonable simplification of minterms

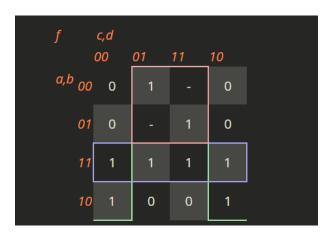
A	\mathbf{C}	D	\mathbf{F}
0	0	0	1
0	0	1	1
0	1	0	0
0	1	1	1
1	0	0	1
1	0	1	0
1	1	0	0
1	1	1	0

```
\begin{array}{l} \operatorname{minterms} = \overline{ABC} + \overline{ABC} + \overline{ABC} + A\overline{BC} \\ \overline{AB} + \overline{ABC} + A\overline{BC} & (C + \overline{C} = 1, \text{ Complementarity law}) \\ \overline{A(\overline{B} + BC)} + A\overline{BC} \\ \overline{ABC} + A\overline{BC} + \overline{ABC} + A\overline{BC} & (C + \overline{C} = 1, \text{ Complementarity law}) \\ \overline{ABC} + A\overline{BC} + \overline{ABC} & (A + A = A, Idempotent \ law) \\ \overline{AC} + A\overline{BC} & (B + \overline{B} = 1, \text{ Complementarity law}) \end{array}
```

It is possible to have a simpler expression

- **3.** (10 points) Given the function $F(A, B, C, D) = \sum m(1, 7, 8, 10, 12, 13, 14, 15) + d(3, 5)$.
 - Draw the Karnaugh map for the function
 - Find all prime implicants
 - List all essential prime implicants
 - Find a minimal SOP. Is your solution unique? If not give an alternate solution.

Solution: 10 points – 4 points for kmap, 2 points each for the rest



• PIs: $\overline{A}D, BD, AB, ACD, AC\overline{D}$

• Essential PIs: $\overline{A}D, AB, ACD, AC\overline{D}$

Minimum SOP:

 $F(A, B, C, D) = \overline{A}D + A\overline{D} + AB$

Many others are possible

4. (10 points) Simplify the boolean expression $F(A, B, C, D) = \Sigma m(1, 7, 8, 10, 12, 13, 14, 15) + d(3,5)$ using the Quine-McCluskey tabular method.

Solution: 10 points - 2 points for grouping and binary representation, 4 points for the two matching steps, 2 points for the prime implicant chart, 2 points for the reduced expression

1. Binary presentation and grouping

2. Matching Step 1

Group B1 1,5 0-01
$$\rightarrow$$
 8,10 10-0 \rightarrow 8,12 1-00 \rightarrow 10,14 1-10 \rightarrow 12,13 110- \rightarrow 12,13 110- \rightarrow Group B2 12,14 11-0 \rightarrow 5,7 01-1 \rightarrow 5,13 -101 \rightarrow 7,15 -111 \rightarrow Group B3 (A3,A4) 13,15 11-1 \rightarrow 14,15 111- \rightarrow

3. Matching Step 2

4. Prime Implicant Chart

									,
PIs\Minterms	1	7	8	10	12	13	14	15	a,b,c,d
1,3,5,7	Х	Х							01
8,10,12,14			Χ	Χ	Х		Х		10
12,13,14,15					Х	Х	Х	Χ	11
5,7,13,15		Х				Χ		X	-1-1

5. Reduced Expression $F(A, B, C, D) = \overline{A}D + A\overline{D}$