Problem 1.

AgtB

A	B	C
0	0	0
0	1	0
1	0	1
1	1	0

$C = A\bar{B}$

AleB

A	B	C
0	0	1
0	1	1
1	0	0
1	1	1

$C = \bar{A} + B$

AeqB

A	B	C
0	0	1
0	1	0
1	0	0
1	1	1

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

AneB

A	B	C
0	0	0
0	1	1
1	0	1
1	1	0

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

AltB

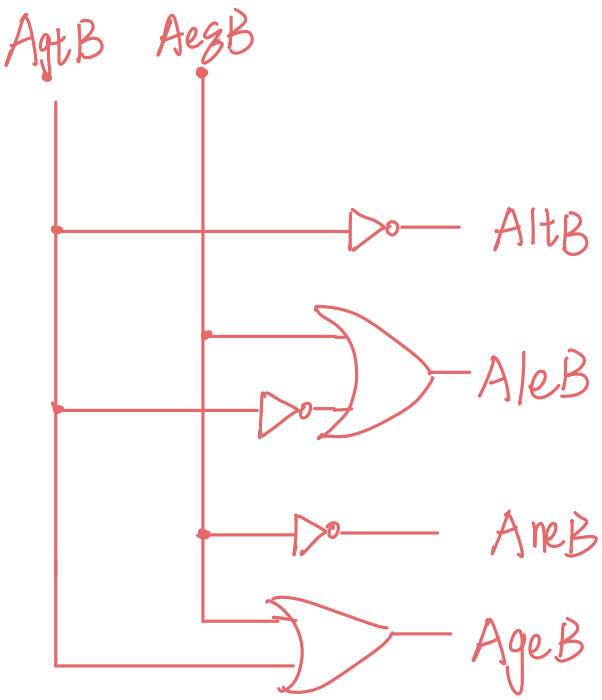
A	B	C
0	0	0
0	1	1
1	0	0
1	1	0

$C = \bar{A}B$

AgeB

A	B	C
0	0	1
0	1	0
1	0	1
1	1	1

$C = A + \bar{B}$



Problem 2

```
MOV   X15, #1
MOV   X1, X0
```

```
LDR  X2 [X1]
ADD  X1, X1, #4
LDR  X3 [X1]
ADD  X1, X1, #4
LDR  X4 [X1]
CMP  X2, X3
BLE  L1
MOV  X15, #0
B L2
L1:
CMP  X3, X4
BLE  L2
MOV  X15, #0
L2:
```

Problem 3:

```
LSR X1, X0, #2
ADD X1, X1, X0
```

o

Problem 4

a) CPU $Time_A = \frac{1}{3.5GHz} \cdot 1.5 = 4.29 \times 10^{-10} s$ $IPS = 2.3 \times 10^9$

CPU $Time_B = \frac{1}{2.8GHz} = 3.57 \times 10^{-10} s$ $IPS = 2.8 \times 10^9$

CPU Time$_C$ = $\frac{1}{4\,GHz} \cdot 2.2 = 5.5 \times 10^{-10}$ s IPS = 1.82×10^9

P_2 has highest performance

b) P_1 : 7×10^{10} cycles 4.7×10^{10} instructions

P_2 : 5.6×10^{10} cycles 8.6×10^{10} instructions

P_3 : 8×10^{10} cycles 3.64×10^{10} instructions

c) $t = CPI \cdot \frac{1}{CR}$

$0.7t = 1.15\,CPI \cdot \frac{1}{x \cdot CR}$

$0.7 = \frac{1.15\,CPI}{x \cdot CR} \cdot \frac{CR}{CPI}$

$x = 1.64$

New clock rate : P_1 : 5.7 GHz

P_2 = 4.6 GHz

P_3 = 6.6 GHz

Problem 5:

a. Class A: 1×10^5 instructions

B: 2×10^5 instructions

C: 4×10^5 instructions

D: 3×10^5 instructions

P_1 : $T = \frac{1 \times 10^5 + 4 \times 10^5 + 12 \times 10^5 + 12 \times 10^5}{2.8 \times 10^9} = 1.04 \times 10^{-3}$ s

P_2 : $T = \frac{2 \times 10^5 + 6 \times 10^5 + 8 \times 10^5 + 9 \times 10^5}{3.5 \times 10^9} = 7.14 \times 10^{-4}$ s

second implementation is faster.

b. P_1 : $1.04 \times 10^{-3} \cdot 2.8 \times 10^9 = 2.9 \times 10^6$ cycles

P_2 : $7.14 \times 10^{-4} \cdot 3.5 \times 10^9 = 2.5 \times 10^6$ cycles

Global CPI for P_1 : 2.9

$P_2 = 2.5$

c) Clock cycles: $P_1 = 2.9 \times 10^6$

$P_2 = 2.5 \times 10^6$.

Problem 6:

a) $CPI_A = \frac{1.1\ s}{1 \times 10^{-9}\ ns \cdot 1 \times 10^9} = 1.1$

$CPI_B = \frac{1.4}{1 \times 10^{-9} \cdot 1.3 \times 10^9} = 1.08$

b) $CR = \frac{\text{Instruction count} \cdot CPI}{\text{execution time}}$

$\frac{CR_A}{CR_B} = \frac{10^9 \cdot 1.1}{t} \cdot \frac{t}{1.3 \times 10^9 \cdot 1.08} = 0.78$

CR of processor running A is 22% slower than the processor running B

c) A: $\frac{1 \times 10^9 \times 1.1}{6 \times 10^8 \times 1.1} = 1.67$

B: $\frac{1.3 \times 10^9 \times 1.08}{6 \times 10^8 \times 1.1} = 1.9$