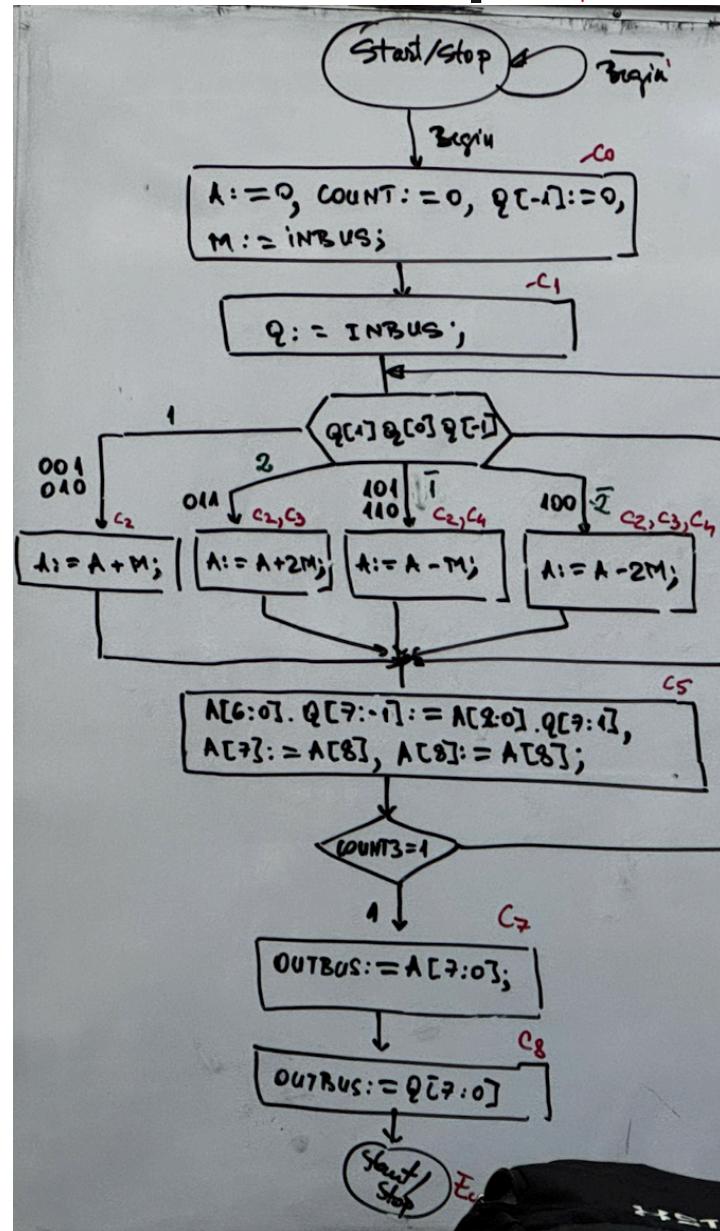


CNT	A	Q	Q-1	M
000	0000 0000 +0011 0111	1001 0011 0011 0111	0 1	1100 1001 1001 0011
001	0000 0110 +1100 1001	11100100 11101011	1 0	11 11
011	1111 0010 +0011 0111	01110010 00101100	0 1	01 +
100	0001 0110 +0011 0111	01001100 00101100	1 0	-
101	+1100 1001 1101 1111	11101111 10101110	0 0	
110	1111 0111 +0011 0111	11010111 00101110	0 1	
111	+0011 0111 0010 1110	00010111 00010111	1 1	
		00010111 01101011	1	END



X _{i+1}	X _i	X _{i-1}	operator
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	2
1	0	0	2
1	0	1	1
1	1	0	1
1	1	1	1

CNT	A	Q	Q-1
00	0000 0000 +1101 0110	1000 1011 1101 0110	0 1
01	+1101 0110 1100 1100	1111 0110 1111 0011	0 0
10	+0010 1001 0001 1100	0100 1100 0000 0110	0 1
11	+1010 1101 1011 0100	1110 1101 1110 0100	1

-117 * 83 = -9711

x_{i+2}	x_{i+1}	x_i	x_{i-1}	Out
0	0	0	1	0
0	0	1	0	1
0	0	1	1	2
0	1	0	0	2
0	1	0	1	3
0	1	1	0	3
0	1	1	1	4
1	0	0	0	0
1	0	0	1	1
1	0	1	0	0
1	0	1	1	1
1	1	0	0	0
1	1	0	1	1
1	1	1	0	0
1	1	1	1	1

Radix B

1, 2, 3, 4 bits
3 shift

Radix 8	$x = -104$	$x = -128 + 24 = -128 + 16 + 8$
	$y = -93$	$y_{C_2} = 10011000$
$2M = 1100111010$	$y = -128 + 29 = -128 + 16 + 8 + 4 + 1$	
$-2M = 0011000110$	$y = 1110011101$	
$\leftarrow 3M = 01000101001$	$-y = 0001100011$	
$\uparrow 3M = 1011010111$		
	$x \times y$	$\frac{1110011101 + 0001100011 + 0001100011}{1011010111}$
		000110001100011011000110
CNT	A	Q
00	000000 0000 000000 0000	110011000 0001100011000
01	1011101 0111 1011101 0111 1111011010	110011000 0001100011000
10	000110001100 00101000000 000100101000 $x = -93 = 10296$	111000110 0001110000

Restoring

W	A	Q	M
000	0010 1101	0001 011 <u>1</u> 0	1000 0111
-	1000 0111		
(1)	0110 0110	0001 011 <u>1</u> 0	
+	1000 0111		
	<u>0110 1101</u>		
	0110 1101	0010 11 <u>0</u> 0	
001	1000 0111		
+	(1) 1010 0011	0010 11 <u>0</u> 0	
	1000 0111		
	<u>0101 1010</u>		
	0111 0100 0101 1 <u>0</u> 00		
010	- 1000 0111		
(1)	0110 1101	0101 1 <u>0</u> 01	
	0101 1010	101 <u>1</u> 0010	
011	- 1000 0111		
(1)	0101 0011	101 <u>1</u> 0010	
+ 1000 0111			
	0101 1010		
	1011 0101 101 <u>1</u> 0100		
100	- 1000 0111		
(1)	0110 1110	011 <u>0</u> 0101	
	0101 1100	11 <u>0</u> 0 1010	
101	- 1000 0111		
(1)	0101 0101	11 <u>0</u> 0 1010	
+ 1000 0111			
	0101 1100		
	1011 1001 1 <u>0</u> 01 0100		
110	- 1000 0111		
(1)	0111 0010	1 <u>0</u> 01 0101	
	0110 0101	0 <u>1</u> 01 1010	

Non Reformation

COUNT	S	A	Q	M
000	0	0010 1101	0001 0110	1000 0111
-	1	1000 0111		
	①	1010 0110	0001 0110	
	1	0100 1100	0010 1100	
001+	0	1000 0111		
	①	1101 0011	0010 1100	
	1	1010 0110	0101 1000	
010	+0	1000 0111		
	②	0010 1101	0101 1001	
	0	0101 1010	1011 0010	
011-	0	1000 0111		
	①	1101 0011	1011 0010	
	1	1010 0111	0110 0100	
100+	0	1000 0111		
	③	0010 1110	0110 0101	
	0	0101 1100	1100 1010	
101-	0	1000 0111		
	④	1101 0101	1100 1010	
	1	1010 1011	1001 0100	
110+	0	1000 0111		
	0	0011 0010	1001 0101	
	0	0110 0101	0010 1010	
111-	0	1000 0111		
	⑤	1101 1110	0010 1010	
001+	0	1000 0111		
	0	0110 0101	(42) 101	
				(101) 101

NFB shift and - unit
1 → + 1-, add a =
0 → - 0 add a 1

gbf

1.4.3 Radix-2 SRT

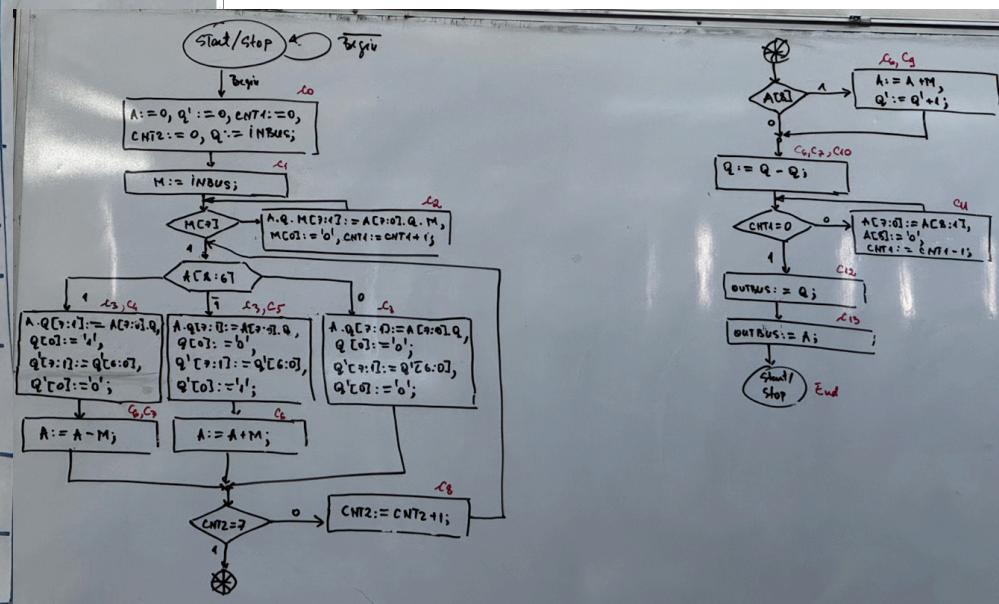
COUNT	P	A	M
000	00000 0000 00001 1010	1001 0000 0000 0000	0000 0101 1010 0000
000	$q_0 = 0$	$00010 0100$	$0000 0000$
001	$q_1 = 1$	$00100 1000$	$0000 0000$
010	$q_2 = 1$	$01001 0000$	$0000 0000$
011	$q_3 = 0$	$11110 0000$	$0000 0000$
100	$q_4 = 0$	$11100 0000$	$0000 0000$
101	$q_5 = 0$	$11000 0000$	$0000 0000$
110	$q_6 = 1$	$10000 0000$	$0000 0000$
111	$q_7 = 1$	$10100 0000$	$0000 0000$
	$+ 01010 0000$	$0001 0000$	$11010 0000$
	$(11100 0000)$	$0000 0001$	$11010 0000$
	$(00010 0000)$	$0010 0000$	$0000 0100$
	$\text{Shift} + 00000 00100$	00011100	$(28)_{10}$
	conv	$(41)_{10}$	$(28)_{10}$

$$\begin{array}{r} 128 \\ 21 \\ \hline 144 \\ 15 \\ \hline 10 \\ 128 \\ \hline 64 \\ 65 \\ \hline 32 \\ 16 \\ \hline 144 \end{array}$$

$\text{CPU time} = (\text{IC} \times \text{CPI}) \times \text{clk cycle time}$

$\text{CCF} = \frac{1}{\text{CR}}$

$\text{MIPS} = \frac{\text{IC}}{\text{CPU time} \times 10^6} = \frac{\text{IC}}{\text{FC} \times \text{CPS} \times \text{CCF}} = \frac{\text{IC}}{\text{Clock Rate} \times 10^6}$



1 SRT-4

b	Range of P	q	b	Range of P	q		
8	-12	-7	-2	12	-18	-10	-2
8	-6	-3	-1	12	-10	-4	-1
8	-2	1	0	12	-4	3	0
8	2	5	1	12	3	9	1
8	6	11	2	12	9	17	2
9	-14	-8	-2	13	-19	-11	-2
9	-7	-3	-1	13	-10	-4	-1
9	-3	2	0	13	-4	3	0
9	2	6	1	13	3	9	1
9	7	13	2	13	10	18	2
10	-15	-9	-2	14	-20	-11	-2
10	-8	-3	-1	14	-11	-4	-1
10	-3	2	0	14	-4	3	0
10	2	7	1	14	3	10	1
10	8	14	2	14	10	19	2
11	-16	-9	-2	15	-22	-12	-2
11	-9	-3	-1	15	-12	-4	-1
11	-3	2	0	15	-5	4	0
11	2	8	1	15	3	11	1
11	8	15	2	15	11	21	2

COUNT	P	A	B
00	00000 0000 00001 1010	1101 0011 0110 0000	0000 0101 1100 0000
00	$q_0 = 1$	$00110 1010$	$1000 0000$
-	$00110 1010$ $- 01010 0000$	$1000 0001$ $0000 0000$	
01	$q_1 = 1$	$00000 0100$	
+	$10010 1010$ $+ 01010 0000$	$00000 0100$ $0000 0000$	
10	$q_2 = 1$	$00000 0000$	
+	$10010 1010$ $+ 01010 0000$	$00000 0000$ $0000 0000$	
11	$q_3 = 1$	$01000 0000$	
+	$10010 0000$ $+ 01010 0000$	$00000 0000$ $0000 0000$	
	$(11100 1010)$	$00000 0000$	
	$(00010 0000)$	$01000 0000$	
	$\text{Shift} + 00010 0000$	$00100 1010$	
	conv	$00000 0001$	
	$\text{remainder } 1_{10}$	$00100 1010$	
	$\text{quotient } 42_{10}$	$00100 1010$	

COUNT	P	A	B
00	00000 0000 00001 1010	1101 0011 0110 0000	0000 0101 1100 0000
00	$q_0 = 0$	$00110 1010$	$1000 0000$
-	$00110 1010$ $- 01010 0000$	$1000 0001$ $0000 0000$	
01	$q_1 = 1$	$00000 0100$	
-	$00000 0100$ $- 01010 0000$	$00000 0000$ $0000 0000$	
10	$q_2 = 1$	$00000 0000$	
-	$00000 0000$ $- 01010 0000$	$00000 0000$ $0000 0000$	
11	$q_3 = 1$	$01000 0000$	
-	$01000 0000$ $- 01010 0000$	$00000 0000$ $0000 0000$	
	$(00010 0000)$	$00000 0000$	
	$\text{Shift} + 00000 0000$	$00100 1010$	
	conv	$00000 0001$	
	$\text{remainder } 1_{10}$	$00100 1010$	
	$\text{quotient } 42_{10}$	$00100 1010$	

remainder = 1₁₀
quotient = 35₁₀

Radius 5

$$\begin{array}{r} -37 \\ \times 2 \\ \hline -115 \end{array}$$

$$-128 + 64 +$$

$$M = 110001101 \quad 2M = 1000011010$$

$$-M = 001110011 \quad -2M = 011100110$$

$$Q = 11011011 \quad ; \quad 0$$

CNT	A	Q	Q_{-1}
00	$ \begin{array}{r} 00000 \\ + 01111 \\ \hline 00111 \\ 00011 \end{array} $	$ \begin{array}{r} 11011011 \\ \underline{11011011} \\ 11101101 \end{array} $	$ \begin{array}{r} 0 \\ \cancel{-M} \\ +2M \\ 1 \end{array} $
01	$ \begin{array}{r} 100011010 \\ + 101010011 \\ \hline 110101001 \end{array} $	$ \begin{array}{r} 11110110 \\ \underline{11110110} \\ 11110110 \end{array} $	$ \begin{array}{r} 0 \\ \cancel{-M} \\ 1 \end{array} $
10	$ \begin{array}{r} 001110011 \\ + 000001100 \\ \hline 000000110 \end{array} $	$ \begin{array}{r} 01110110 \\ \underline{01110110} \\ 01110110 \end{array} $	$ \begin{array}{r} 0 \\ \cancel{-M} \\ 0 \end{array} $
11	$ \begin{array}{r} 001110011 \\ + 001000000 \\ \hline 001000000 \end{array} $	$ \begin{array}{r} 10111011 \\ \underline{10111011} \\ 10111011 \end{array} $	

$$-117 \quad 83$$

$$Q = -128 + 11 = -128 + 8 + 2 + 1 \\ Q = 10001011$$

$$M \quad 83 = 64 + 19 = 64 + 16 + 2 + 1$$

$$M = 001010011$$

$$-M = 110101101$$

$$2M = 010100110$$

$$-2M = 101011010$$

CNT	A	Q	Q_{-1}
00	$ \begin{array}{r} 00000 \\ +11010 \\ \hline 11010 \end{array} $ $ \begin{array}{r} 11101 \\ +0110 \\ \hline 11000 \end{array} $	$ \begin{array}{r} 10001011 \\ +0 \\ \hline 1011 \end{array} $	0 -m
01	$ \begin{array}{r} 01010 \\ +00111 \\ \hline 00011 \end{array} $ $ \begin{array}{r} 00011 \\ +1110 \\ \hline 1110 \end{array} $	$ \begin{array}{r} 11000101 \\ +0 \\ \hline 101 \end{array} $	+2M
10	$ \begin{array}{r} 11010 \\ +11110 \\ \hline 11110 \end{array} $ $ \begin{array}{r} 11110 \\ +01011 \\ \hline 1011 \end{array} $	$ \begin{array}{r} 10110001 \\ +0 \\ \hline 001 \end{array} $	+M
11	$ \begin{array}{r} 00101 \\ +00100 \\ \hline 00100 \end{array} $	$ \begin{array}{r} 01011000 \\ +0 \\ \hline 000 \end{array} $	1

2 — 1
4 — 2
8 — 3

$M \quad 1100001101$
 $-M \quad 001110011$
 $2M \quad 100011010$
 $-2M \quad 011100110$

CNT	A	Q	Q_{-1}
00	$ \begin{array}{r} 000000000 \\ + 000000000 \\ \hline 000000000 \end{array} $	1101011	0
01	$ \begin{array}{r} + 000000000 \\ \hline 000000000 \end{array} $	1111111101	+2M
10	$ \begin{array}{r} + 1000011010 \\ \hline 100111101 \end{array} $	0111111111	-M
11	$ \begin{array}{r} + 0011100110 \\ \hline 0010000110 \end{array} $	0010011111	C
000010000010001111111			

101

64 + 44

6.0 + 01101100

25

SR72 8^{10h}

32 + 8 + 4

25

16 + 9

~~M~~ 00011001
~~M~~ 11100101

~~M~~ 00011001
~~M~~ 01100111 000
~~M~~ 000 / 111 1000
K=3

CNT	9	A	8	2
000	000000000000	011011000000		
001	0000000001101101	10000000000000		
010	000001101011	000000000000		
011	00001101101100	00000000000000		
100	00110110110000	00000000000000		
101	01101100000000 + 10011100000000 ----- 00001100000000	00000000000000		
110	00001000000000	00000000000000		
111	00100000000000	00000000000000		
Shift	00000100000000	00000000000000		

108 / 25

 $M = 011001000 \quad -M = 100111000$

CNT	A	Q
00	0 0000 0000	0 1101100
	0 0000 0011	0 11000000
00	0 0000 01101	100000000
01	0 0011 0110	000000000
10	0 1101 1000	0000000101
+ 1 0011 1000	<hr/> 0 0001 0000	<hr/> 0000000000
	0 0001 0000	0000000000
11	0010000000	000001000

shift

000000 1000

100

228 / 13

$$228 = 128 + \frac{120}{13}$$

$$64 + 36$$

$$\frac{1}{32+4}$$

13

1101

K=3

$$\begin{array}{r}
 M 0000 1101 \\
 -M 1111 0011 \\
 \hline
 \end{array}$$

CNT	S	A	Q
000	0	0 0 0 0 0 0 0 0 0 0	1 1 1 0 0 1 0 0
	+ 1	$ \begin{array}{r} 1 1 1 1 1 0 0 1 1 \\ 1 1 1 1 1 0 0 1 1 \\ 1 1 1 1 0 0 1 1 1 \end{array} $	$ \begin{array}{r} 1 1 1 0 0 1 0 0 \\ 1 1 0 0 1 0 0 0 \end{array} $
001	+ 0	0 0 0 0 1 1 0 1	$ \begin{array}{r} 1 1 0 0 1 0 0 0 \\ 1 0 0 1 0 0 0 0 \end{array} $
	+ 1	$ \begin{array}{r} 1 1 1 1 0 1 0 0 \\ 1 1 1 1 0 1 0 0 \end{array} $	
010	+ 0	0 0 0 0 1 1 0 1	
	+ 1	$ \begin{array}{r} 1 1 1 1 0 1 1 0 \\ 1 1 1 1 0 1 1 0 \end{array} $	
011	+ 0	0 0 0 0 1 1 0 1	
	+ 1	$ \begin{array}{r} 1 1 1 1 1 0 1 0 \\ 1 1 1 1 1 0 1 0 \end{array} $	0 1 0 0 0 0 0 0
100	+ 0	0 0 0 0 1 1 0 1	
	+ 1	$ \begin{array}{r} 0 0 0 0 0 0 0 1 \\ 0 0 0 0 0 0 0 1 \end{array} $	0 1 0 0 0 0 0 1
	+ 0	0 0 0 0 0 0 1 0	1 0 0 0 0 0 0 1 0
101	+ 1	1 1 1 1 0 0 1 1	
	+ 0	$ \begin{array}{r} 1 1 1 1 0 1 0 1 \\ 1 1 1 1 0 1 0 1 \end{array} $	0 0 0 0 0 1 0 0
110	+ 0	0 0 0 0 1 1 0 1	
	+ 1	$ \begin{array}{r} 1 1 1 1 1 0 0 0 \\ 1 1 1 1 1 0 0 0 \end{array} $	0 0 0 0 1 0 0 0
111	+ 0	0 0 0 0 1 1 0 1	
	+ 1	1 1 1 1 1 1 0 1	
CORR	+ 0	0 0 0 0 1 1 0 1	
	+ 0	0 0 0 0 1 0 1 0	

Type	CPI	IC	
A	3	$35 \cdot 10^7$	$CCT = 0.6 \text{ ns}$
B	2	$105 \cdot 10^6$	$CR = \frac{1}{CCT} = \frac{1}{0.6 \cdot 10^{-9}}$
C	2	$400 \cdot 10^6$	
Bn	3	$16 \cdot 10^7$	$\frac{10}{6} \cdot 10^9 \text{ Hz}$

a) $CPU_{Time} = CPI \times IC \times CCT$

$$= \frac{1}{0.6 \cdot 10^{-9}} \cdot \frac{10}{6} \cdot 10^9 \text{ s} = \frac{5}{3} \text{ GHz} = 1,66 \text{ GHz}$$

~~Clk~~ \cdot ~~Z~~ \cdot ~~%~~ $\frac{1}{Clk}$

$$CC = 3 \cdot 35 \cdot 10^7 + 2 \cdot 105 \cdot 10^6 + 2 \cdot 400 \cdot 10^6 + 3 \cdot 16 \cdot 10^7$$

$$= (1050 + 310 + 800 + 480) \cdot 10^6$$

$$= 2540 \cdot 10^6$$

$$CPU_{Time} = 2540 \cdot 10^6 \cdot \frac{6}{10} \cdot 10^{-9} \text{ s}$$

$$= 15240 \cdot 10^{-3} = \underline{\underline{1,524 \text{ s}}}$$

$$MIPS = \frac{IC}{CPU_{Time} \cdot 10^6}$$

$$= \frac{(350 + 105 + 400 + 160) \cdot 10^6}{1,524 \cdot 10^6} = \frac{1015}{1,524} =$$

$$MIPS = 666$$

CPI_B new \rightarrow 2x Faster

$$\frac{CPU_{time\ old}}{new} = 2 \rightarrow CPU_{time\ new} = 0,762$$

$$CC_{new} = 3,35 \cdot 10^7 + \cancel{x \cdot 105 \cdot 10^6} + 2 \cdot 400 \cdot 10^6 \\ + 3 \cdot 16 \cdot 10^7 \\ = (2330 + 105x) \cdot 10^6$$

$$0,762 = (2330 + 105x) \times \frac{6}{20} \cancel{10^{-5}} \cdot \cancel{10^6} \cancel{10^{-5}}$$

$$\cancel{7620} \cancel{1270} = 2330 + 105x$$

$x < 0$ Impossible

$$\frac{2 \cdot 10^5 \cdot 10^6}{2330 \cdot 10^6} = \frac{210}{2330}$$

1

$$\frac{old}{new} = 1,5$$

Exec Time Improved
 $A, C \rightarrow 25\%$
 $B, D \rightarrow 40\%$

$$CC = 3 \cdot 35 \cdot 10^2 \cdot \frac{2}{100} \xrightarrow{\frac{10}{5} \cdot 2^9 = 2 \text{GHz}}$$

$$P_1 \quad CCT = 0.5 \text{ns} = 2 \text{GHz} \quad P_2 = 3 \text{GHz}$$

ALU	3	2	1	20%
L/S	2		2	20%
Br	2		3	33%
Int	2		2	20%
FP	3		5	10%

$$IC = 2.8 \cdot 10^6$$

$$\overbrace{CPU}^{time} CC_1 = 3 \cdot \frac{20}{100} + 2 \cdot \frac{20}{100} + 3 \cdot \frac{30}{100} + 2 \cdot \frac{20}{100} + \frac{10}{100}$$

$$CPU_{time} = \frac{CC}{CR}$$

$$MFQS = \frac{IC}{CPU_{time} \cdot 10^6} = \frac{IC \cdot CR}{CC \cdot 10^6}$$

