(8 marks) Q5B A DAC is used to control the speed of a motor. The 0 to 4 mA analog current from the DAC is amplified to produce motor speed from 0 to 2000 rpm. Explain how many bits should be used to produce a motor speed that is within 1 rpm of the desired speed?

$\frac{2000}{1023} = k$

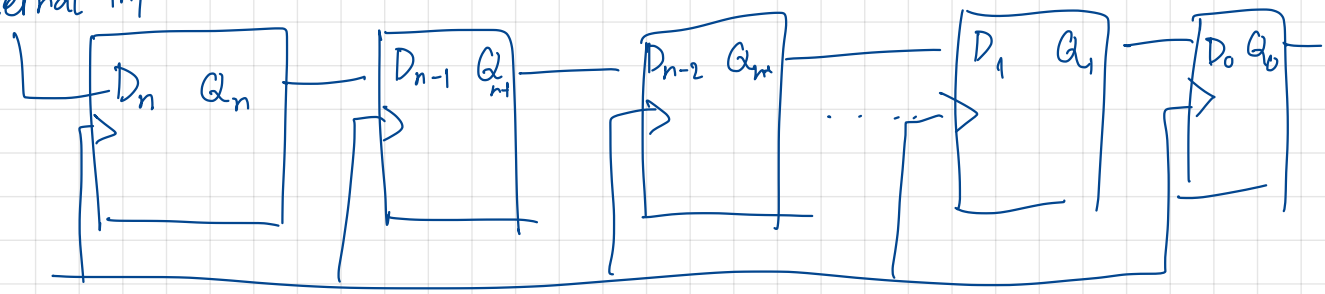
501 - - - -
500 ↕ 2 rpm
499 - - - -

$\frac{2000}{2} = 1000$ steps $= 2^{10}$

10 bits

n bits right shifters

external input



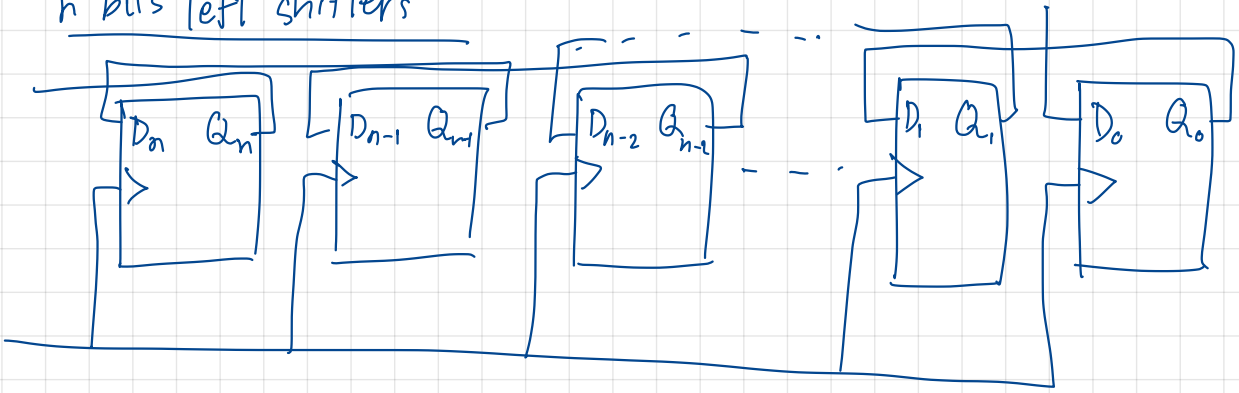
0 1 1 0

I 0 1 1

I I 0 1

n bits left shifters

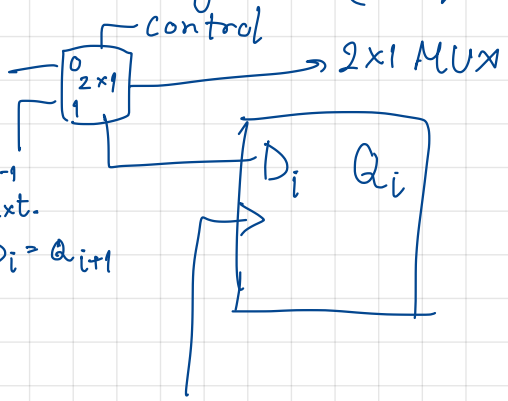
external input



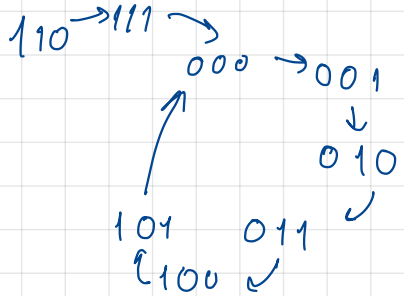
Shift register (left/right) $0 \le i \le n$

if i==0
D_i = ext
then D_i
= Q_{i-1}

if i==n-1
D_i = ext.
then $D_i = Q_{i+1}$



MOD 6 synchronous counter using JK



PS			NS			J_C	K_C	J_B	K_B	J_A	K_A
C	B	A	C	B	A						
0	0	0	0	0	1	0	x	0	x	1	x
0	0	1	0	1	0	0	x	1	x	x	1
0	1	0	0	1	1	0	x	x	0	1	x
0	1	1	1	0	0	1	x	x	1	x	1
1	0	0	1	0	1	x	0	0	x	1	x
1	0	1	0	0	0	x	1	0	x	x	1
1	1	0	1	1	1	x	0	x	0	1	x
1	1	1	0	0	0	x	1	x	1	x	1

	J	k
0 → 0	0	x
0 → 1	1	x
1 → 0	x	1
1 → 1	x	0

$J_A = 1$ $K_A = 1$

$J_B = \bar{C}A$ $K_B = A$

$J_C = BA$ $K_C = A$

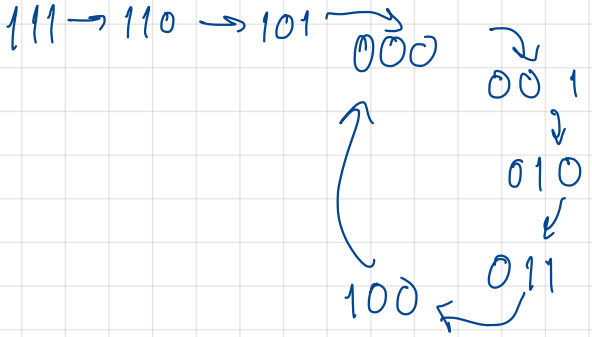
J_B

C \ BA	00	01	11	10
0	0	1	x	x
1	0	0	x	x

K_C

C \ BA	00	01	11	10
0	x	x	x	x
1	0	1	1	0

MOD -5 synchronous counter using JK



excitation table

	J	k
0 → 0	0	x
0 → 1	1	x
1 → 0	x	1
1 → 1	x	0

PS			NS			J_C	K_C	J_B	K_B	J_A	K_A
C	B	A	C	B	A						
0	0	0	0	0	1	0	x	0	x	1	x
0	0	1	0	1	0	0	x	1	x	x	1
0	1	0	0	1	1	0	x	x	0	1	x
0	1	1	1	0	0	1	x	x	1	x	1
1	0	0	0	0	0	x	1	0	x	0	x
1	0	1	0	0	0	x	1	0	x	0	x
1	1	0	1	0	1	x	0	x	1	1	x
1	1	1	1	1	0	x	0	x	0	x	1

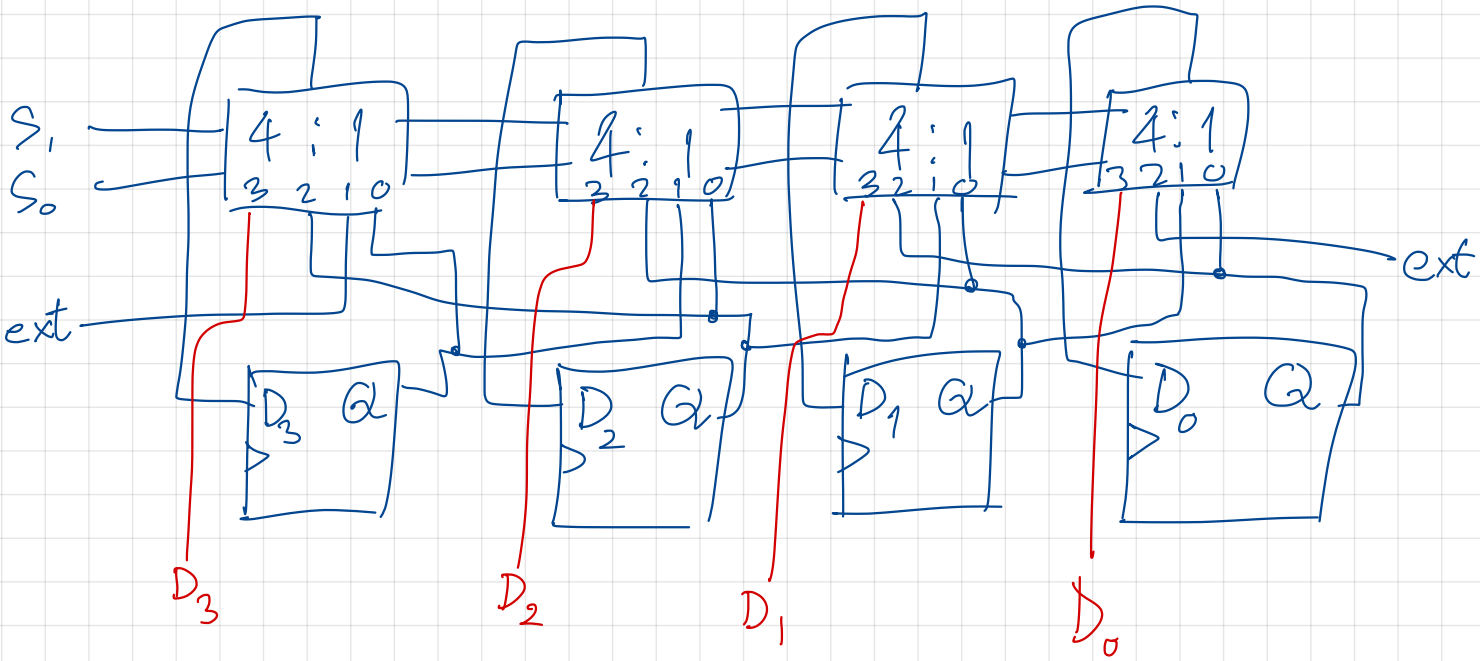
$K_A = 1$ $K_B = \bar{C}A + C\bar{A}$

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

$K_C = \bar{B}$

$J_C = BA$

S_1	S_0	
0	0	Hold
0	1	R
1	0	L
1	1	Parallel



A	B	B_{in}	Diff	Bout
0	0	0	0	0
0	0	1	1	1
0	1	0	1	1
0	1	1	0	1
1	0	0	1	0
1	0	1	0	0
1	1	0	0	0
1	1	1	1	1