

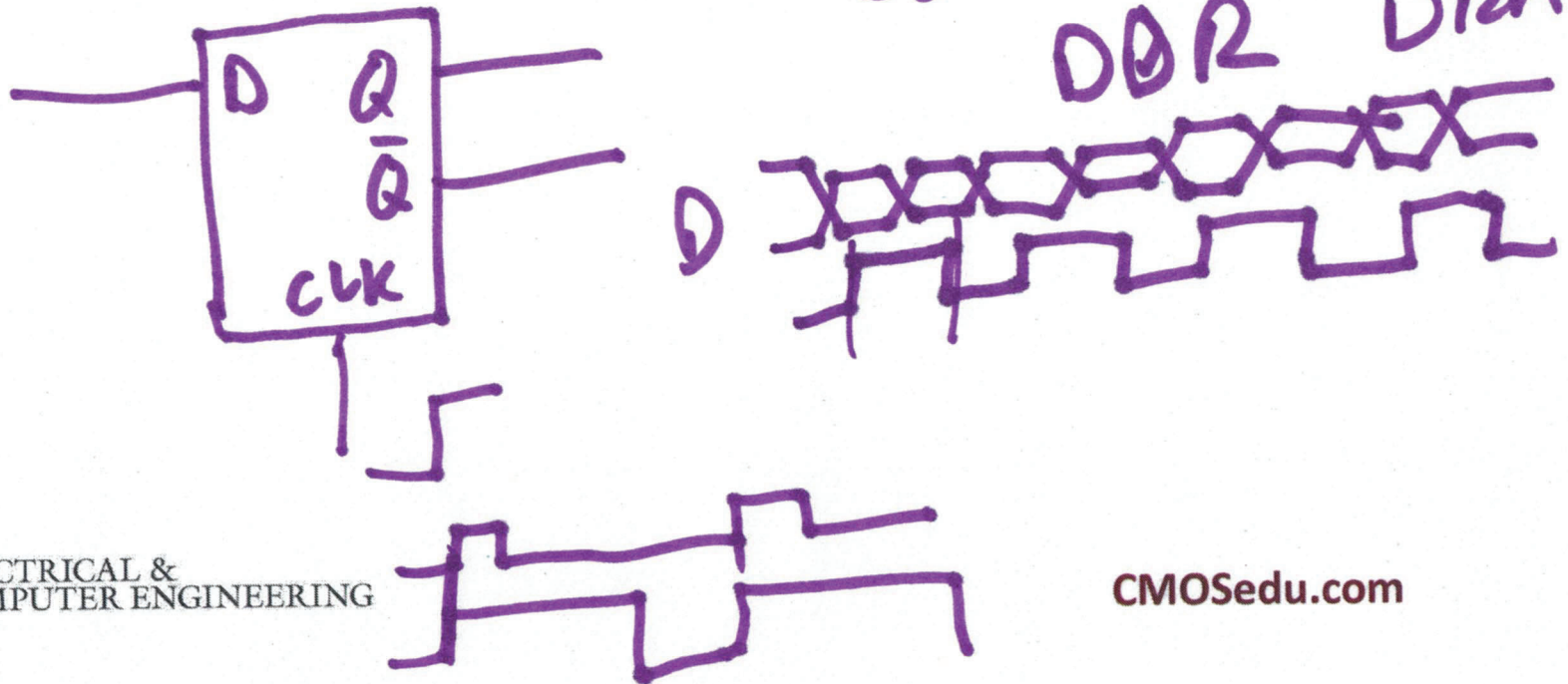
CPE 100 Digital
Logic
Design I

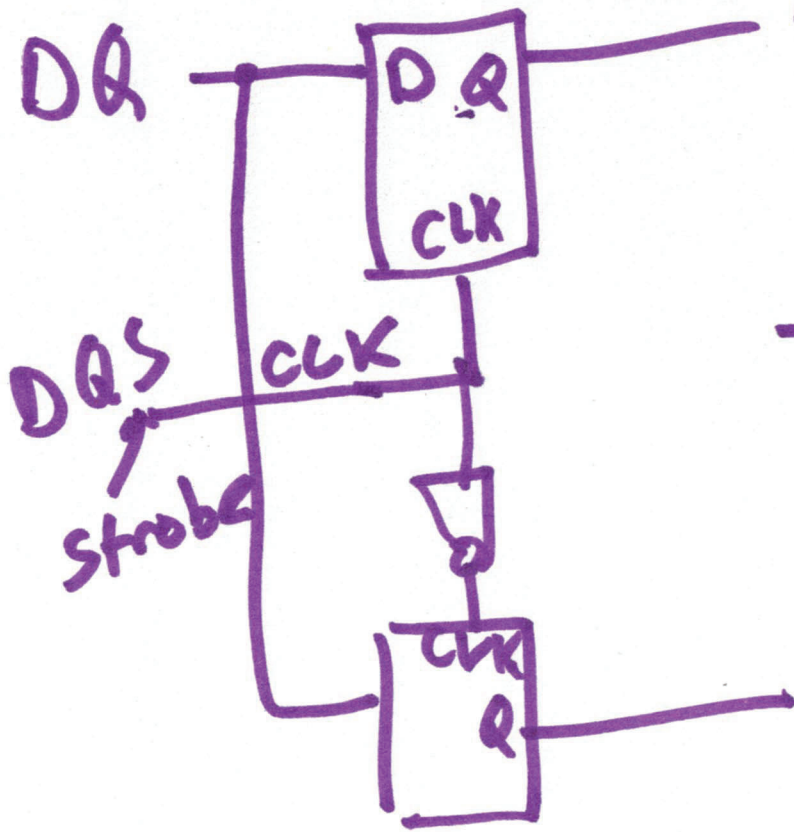
March 27, 2020

Lecture 14

Double-Data-Rate

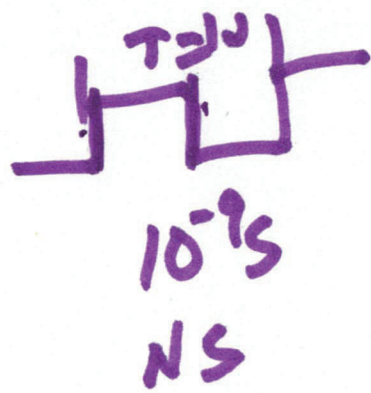
DDR DRAM





1 kHz \Rightarrow 1ms

$$1 \text{ GHz} = 10^9 \text{ Hz}$$



1 per sec

1 billion
sec

$$1 \text{ GHz} = \frac{1}{1 \text{ ns}}$$

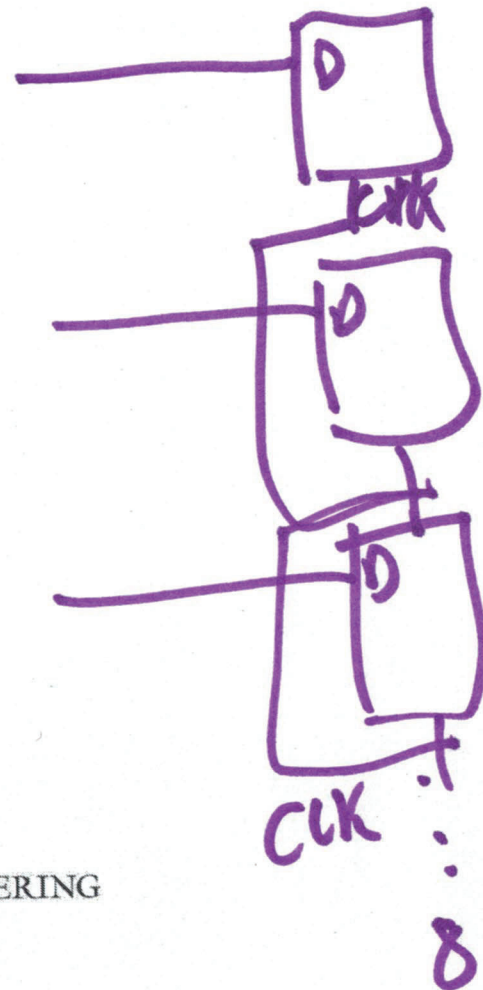
$$\frac{1}{0.5 \text{ ns}} = \frac{1}{500 \text{ ps}}$$

$$f = \frac{1}{T} = 1 \text{ GHz}$$

2)

Registers

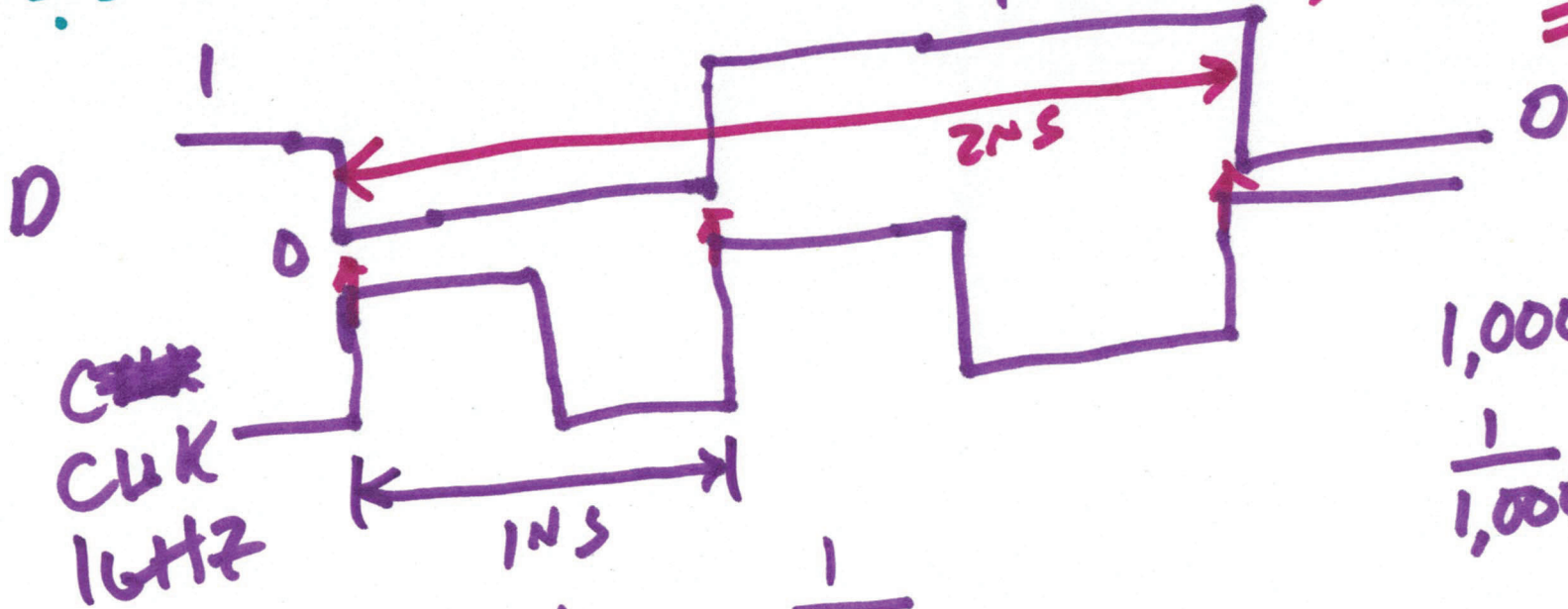
8



3)

Frequency divider
 $\div 2$

Toggle Flip-Flop (TFF)



$$f = \frac{1}{2ns} = .5GHz = 500MHz$$

$$1,000 = 1kHz$$

$$\frac{1}{1,000} = 1ms = T$$

$$f = \frac{1}{1ns} = \frac{1}{10^{-9}s}$$

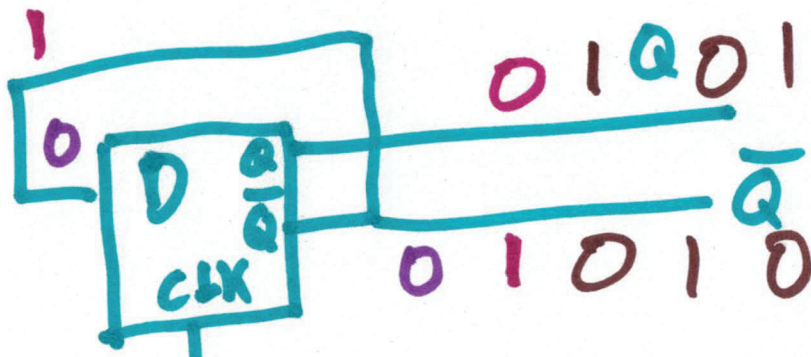
$$= 1GHz = \frac{10^9}{s} = 10^9 Hz$$

work til it MHz

NOT til it KHz

$$1Hz = \frac{1}{s}$$

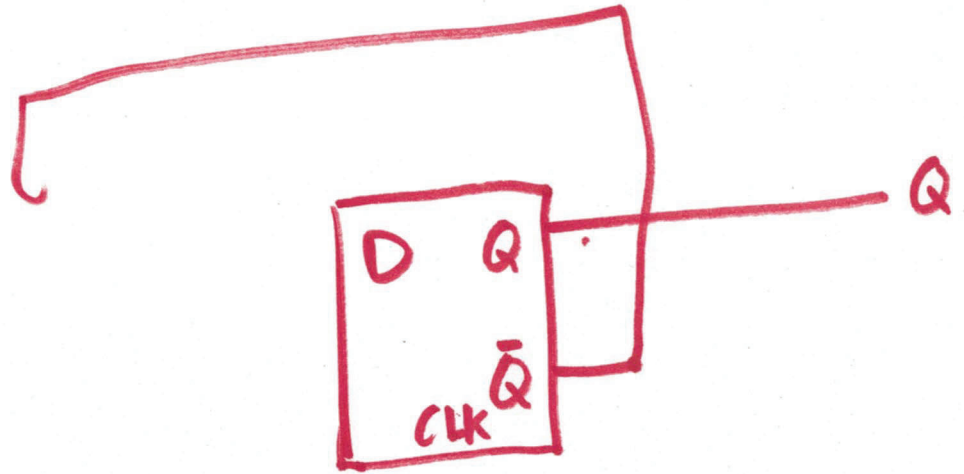
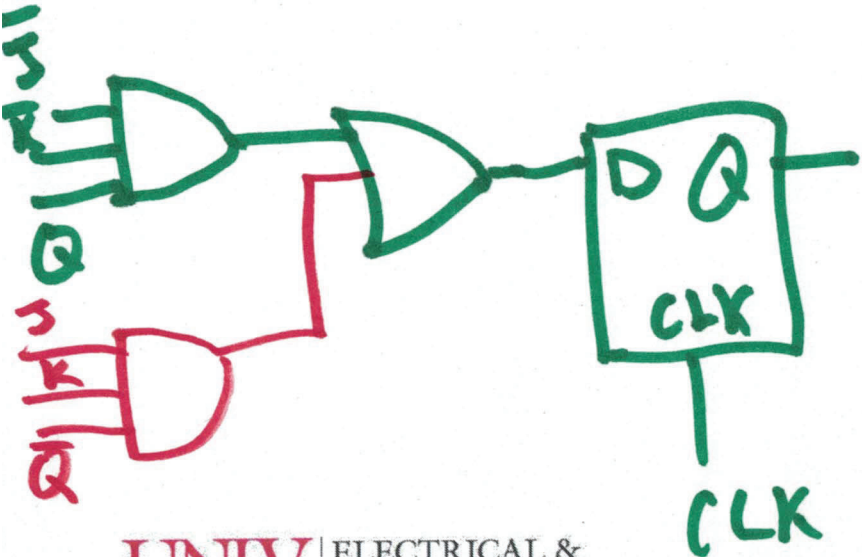
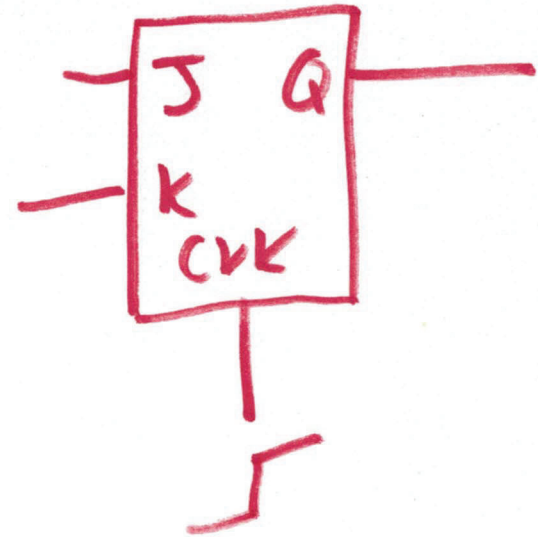
4)



T-Flip Flop

JK Flip-Flop

J	K	Q
0	0	Q
1	0	1
0	1	0
1	1	Q'

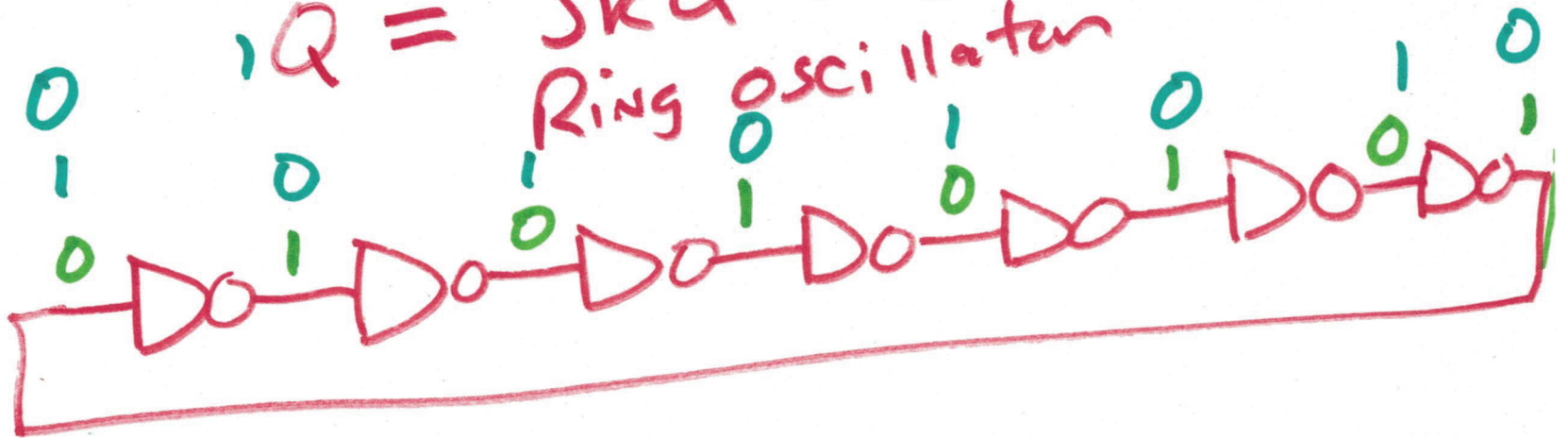


$$Q = \bar{J}\bar{K} \cdot Q + JK + \bar{J}K + JK\bar{Q}$$

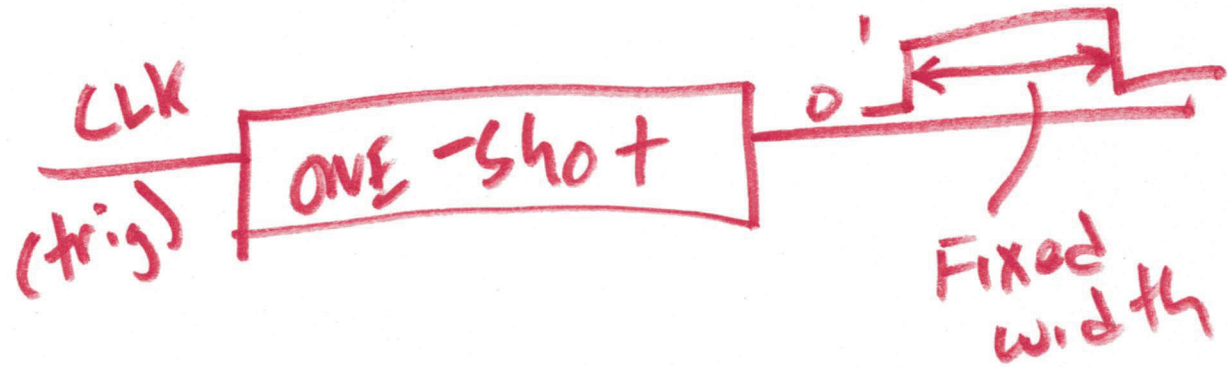
$$\bar{J}\bar{K}Q + JK + (J+K) + JK\bar{Q}$$

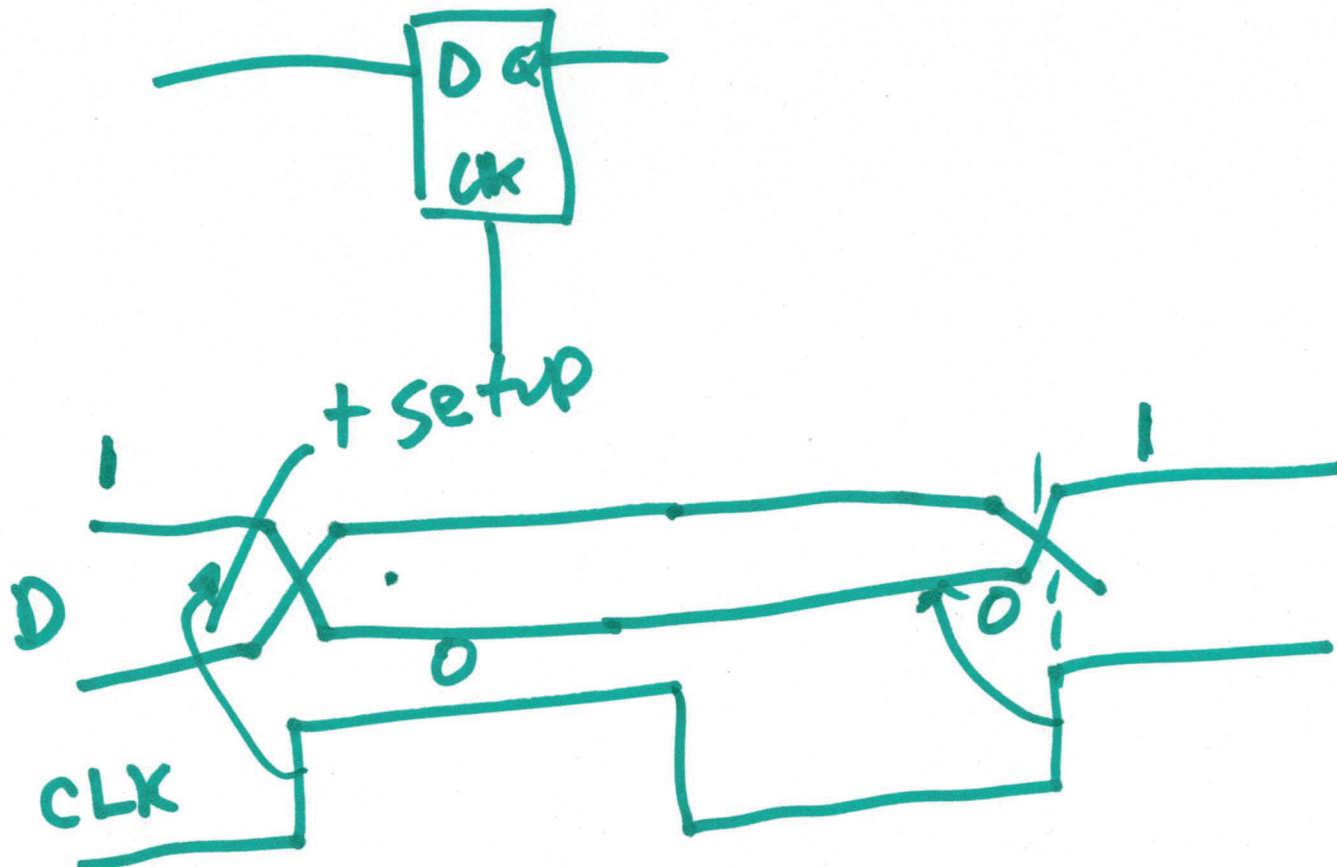
$$Q = \bar{J}\bar{K}Q + JK + JK\bar{Q}$$

Ring oscillator



ONE-shot MONOSTABLE
multivibrator
ASTABLE - OSC
BISTABLE - DFF
MONOSTABLE - ONE-shot





RACE conditions