MECHTRON 3TA4 Summary

Author: Kemal Ahmed
Instructor: Dr. Mark Lawford
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Math objects made using MathType; graphs made using Winplot.

Please join GitHub and contribute to this document. There is a guide on how to do this on my GitHub.

Table of Contents

Chapter 1

Market Window (W): the amount of time, in months, between the on-time entry of the company and peak revenue. It is also the amount of time from peak revenue to when revenue gets to 0. In other words, the entire lifecycle of a product is 2×W

Delay (D): the entry point of a company given a delay

$$\text{Revenue loss depending on entry} = \frac{\text{On-time} - \text{Delayed}}{\text{On-time}} \times 100\%$$

$$\text{Percentage revenue loss} = \frac{D(3W - D)}{2W^2} \times 100\%$$

Design Metrics

Non-Recurring Engineering (NRE) cost: one-time cost to design a system. No more design costs are needed
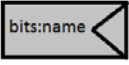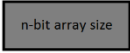
Unit cost: cost of manufacturing one instance of design

Chapter 2

Datapath
1. Identifying variables
2. Identifying operations

State machine data-path symbols:

- Register: `bits:name`
- Multiplexor: `n-bit array size`
- Operations: regular white rectangles

Op-Amps

Operational Amplifiers:
- outputs attempt to do whatever is necessary to make the voltage difference between the inputs zero
- inputs draw 0 current

Ideal characteristics of op-amps:
1. Infinite voltage gain
2. Infinite input impedance
3. Zero output impedance
4. Infinite bandwidth
5. Zero input offset voltage (i.e., exactly zero out if zero in).

Slew rate: maximum rate of change of voltage / s
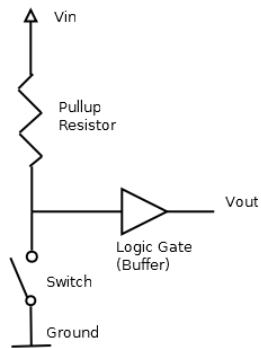
$v_{out} = v_o$
$v_{in} = v_i$

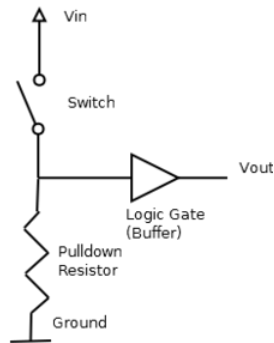**Gain**: [K] $\qquad v_o = K\left(v_+ - v_-\right) + K_{cm}\dfrac{v_+ + v_-}{2}$

Differential Mode Gain: [K_d] $K_d = \dfrac{v_o}{v_d}, v_d = v_1 - v_2$

Common Mode Gain: [K_{cm}] $K_{cm} = \dfrac{v_o}{v_{cm}}, v_{cm} = \dfrac{v_1 + v_2}{2}$

Pull up resistor: When the switch is open, the pull-up resistor brings the voltage up, while when it's closed, v goes to ground

Pull down resistor:

Pulse-Width Modulation (PWM): a technique for getting analog results with digital means
e.g. To create a 3V signal given a digital source that can be either high (on) at 5V or low (off) at
0V, you can use PWM with a duty cycle of 60% which outputs 5V 60% of the time. If the digital
signal is cycled fast enough, then the voltage seen at the output appears to be the average voltage

Transfer function: $[G(s)]$ a function that represents what the system does to the voltage

$$G(s) = \frac{v_o}{v_i} = \frac{Z_2}{Z_1 + Z_2}$$

Units: V/mV (to reduce the number of 0's

Common Mode Rejection Ratio (CMRR): measured in dB

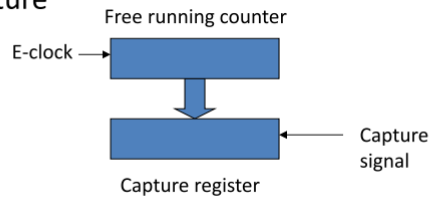$$CMRR = 20\log_{10}\left(\frac{K_d}{|K_{cm}|}\right)$$

Actuator:

Input impedance: impedance of input lead(s)
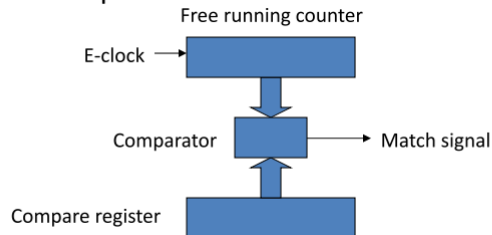**Output impedance**: impedance of output lead(s)

Angular Resolution: $\theta = \dfrac{360°}{\text{\# of steps}}$

Input capture

Free running counter

E-clock →

When an input signal arrives, the value in the counter is automatically latched into a capture register

Capture signal → Capture register

Capture register

Output compare

Free running counter

E-clock →

When the value in the counter matches a value in a compare register, an output signal is automatically generated

Comparator → Match signal

Compare register

When the counter gets to the time held in the compare register, the comparator sends a match signal, sparking an event.

Stepper Motors

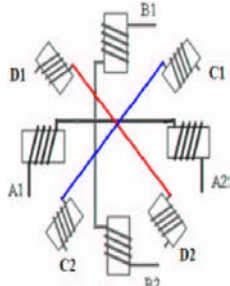**Poles**: Most magnets have 2 poles, but a magnet in the shape of an asterisk (*) has 6 poles
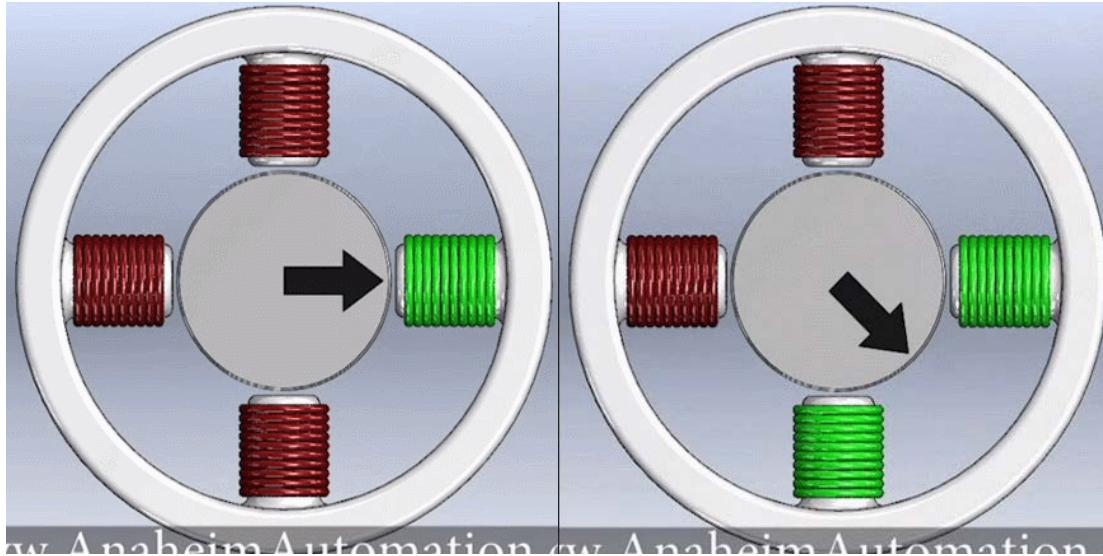- maintains number of wires
- increased resolution
- higher magnet cost
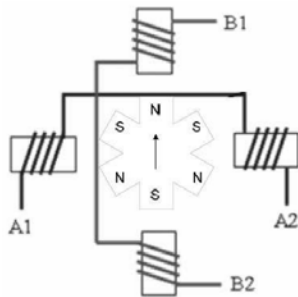
Phases: number of windings (the cork-looking thingys)
- more windings, more wires

Angular resolution: $\theta = \dfrac{360°}{\text{steps}} = \dfrac{360°}{n \times (\text{\# of poles})}$, n = number of phases

Half-stepping: alternating between 2 phase and single phase; reduces torque, but increases speed

Micro-stepping: take the half-step model, but vary the current levels in the magnets to make tinier steps
http://en.nanotec.com/support/tutorials/stepper-motor-and-bldc-motors-animation/

Brushes: