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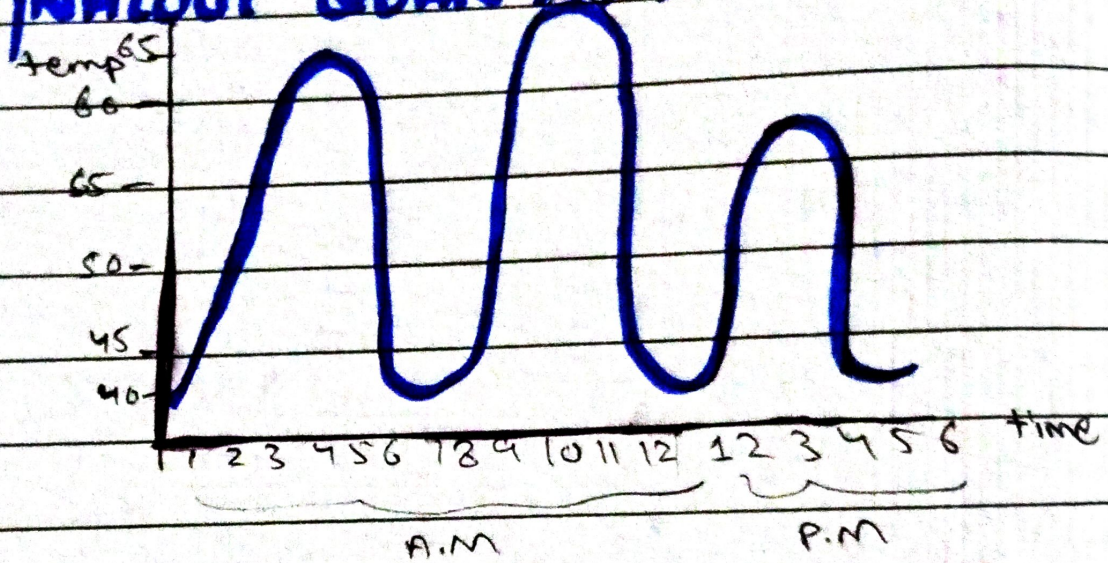
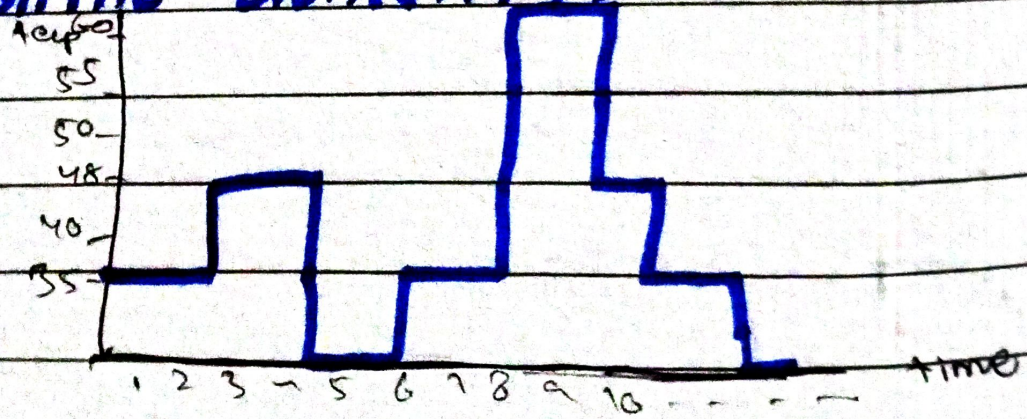
ANALOG QUANTITY:



DIGITAL QUANTITY:



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Analog & digital quantities
LOGIC DESIGN

DIGITAL LOGIC DESIGN:

ANALOG QUANTITY:

~~smooth~~ & infinite range of possible values within a given range

is one having continuous values

for example: temperature, voltage & pressures.

Analog quantity have infinite possibilities with in their defined range.

DIGITAL QUANTITY:

distinct, separate values from a finite set.

finite set of discrete value

is one having a discrete set of values.

for example: binary signals, numerical values in binary code, Pixel-based images and digital encoded audio.

DIFFERENCE B/W ANALOG & DIGITAL QUANTITIES:

•) Analog Quantity	•) Digital Quantity
1) Continuous and variable representation.	1) Discrete & quantized representation
2) Infinite values within a specified range.	2) limited & distinct values often in binary
3) Infinite precision, capturing intricate details in the measurement of the analog quantity	3) limited precision, finite set of values.

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(easily influenced)

4) More Susceptible due to continuous nature

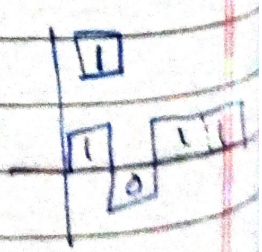
4) less susceptible due to discrete nature

5) Example: Analog Signals, continuous voltage, temperature

5) Example: Digital Signals, binary numbers, pixel value in digital images.

ADVANTAGES OF DIGITAL OVER ANALOG:

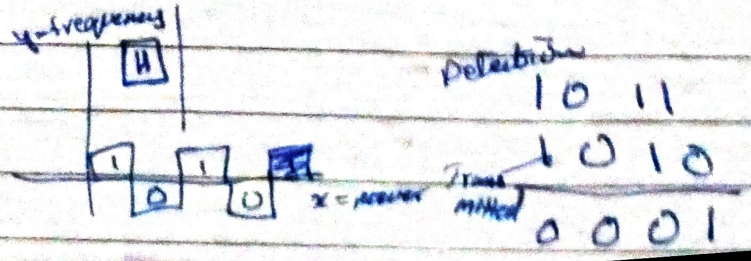
- Digital offers higher precision due to discrete, well-defined values.
- Digital Signals are less susceptible to noise and interference.
- Digital information can easily stored, copied & reproduced without degradation.
- Digital Signals allows for advanced signals processing & manipulation.
- Digital Systems enable efficient error detection & correction.



in Digital

x > 0 → 1 → High

x ≤ 0 → 0 → low



Q Name a system that is entirely digital

Ans. Computer System

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EXAMPLES OF DIGITAL AND ANALOG QUANTITYS

DIGITAL QUANTITYS

- Microprocessor : (process & store data in binary form)
- Digital Communication (Digital signals transmit information in technologies like wifi, other networks)
- Digital Display (LEDs & LCDs use digital signals to display ~~signals~~ information)
- Digital Audio (MP3 player & CDs encode audio as Digital Signal)

ANALOG QUANTITYS

- Analog Sensors (temperature sensors provide analog voltage signals proportional to temperature)
- Amplifiers (Analog amplifiers increase the strength of continuous analog signals.)
- Analog Radio (AM & FM radio transmit information through continuous analog signals.)
- Analog Oscillators (used in generating continuous waveforms for various applications)

MECHATRONICS:

The inter-disciplinary field that comprises both mechanical and electronic components is known as mechatronic.

Example

washing machine, manufacturing industries such as automotives and other type of manufacturing robotic arms ~~painting~~

t = 0 —— test point

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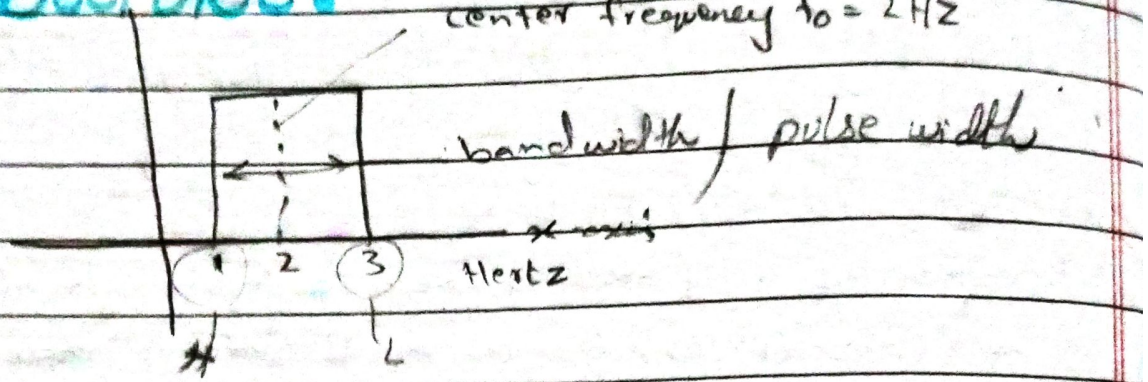
LECTURE: 1.2



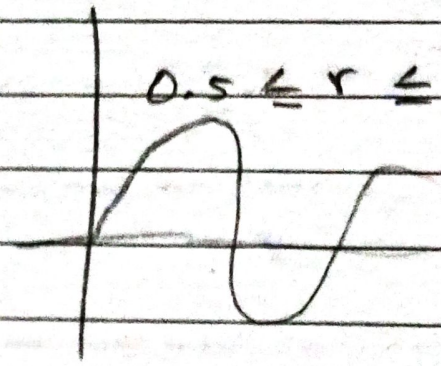
bandwidth/pulse width = High frequency − low fre

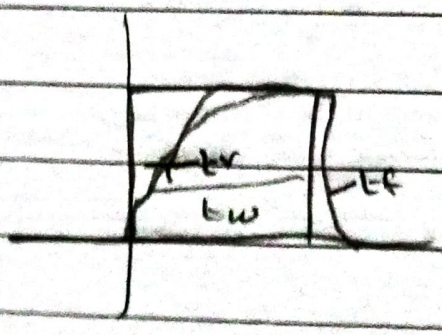
3 − 1

BW = 2Hz

$r > 0.5$ & $r \geq 10$ ⟶ high

$r > 0.5$ & $r \geq 10$ ⟶ low





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1.2:

BINARY DIGIT & BITS:

"The two-state ~~dig~~ number system is called binary, and it's two digits are 0 and 1. The binary digit is called bit.

~~There are two types of bits in~~ In binary system ~~digits~~, the two bits typically represented as 0 and 1.

* High → 1
  low → 0

This is called positive logic

* High → 0
  low → 1

This is called negative logic

LOGIC LEVELS

The voltages used to represent a 1 & 0 are called logic levels.

Both HIGH & LOW can be any voltage b/w a specified minimum value & Specified maximum value.

No overlap the accepted range of HIGH & LOW level.

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$V_{H(max)}$: Maximum HIGH voltage value.

$V_{H(min)}$: Minimum HIGH voltage value.

$V_{L(max)}$: Maximum Low voltage value.

$V_{L(min)}$: Minimum low voltage value.

RANGE: The input value of a certain type of digital circuit technology from:

HIGH : 2V to 3.3V

LOW : 0V to 0.8V

if the 2.5 voltage is applied, the circuit will accept it as a High or binary 1.

If the voltage is 0.5 applied, the circuit will accept it as a low or binary 0.

DIGITAL WAVEFORMS :

Digital waveform consists of voltage levels that can be change from back & forth b/w HIGH & LOW levels.

A digital waveform is made up of series of pulses.

ay: Date:

a) When the single positive pulse is generated, when the voltage goes normally to ↑ level to it's High level then comeback to it's low level (low)

Same as negative going pulse. High to low the comebacke to high level.

PULSE

t_0 ⇒ leading edge
t_1 ⇒ trailing edge

*) for positive-going pulse, the leading edge is a rising edge while the trailing edge is a falling edge

reverse process
~~Same~~ ⇒ in negative-going pulse. rise trailing edge & fall leading edge.

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FIGURE 1.8:

The time required for pulse go from low level to high level is called rise time (t_r) & the time required for the transition from HIGH to low level called fall time (t_f).

The pulse amplitude measure rise from 10% to the 90%. the remaing 10% are not include because of non linearities in the wave form. So the rising and falling the pulse b/w 10% to 90%. whereas at 50% the pulse width is a time interval b/w 50% point rising and falling edge.

WAVEFORM CHARACTERISTICS:

Most waveforms are composed in series of pulses, sometimes called pulse trains.
It can be classified in periodic or non periodic wave.

* A periodic pulse waveform is one that repeat itself and having fixed interval called time

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period (T). The frequency (f) is the rate at which it repeat itself and measured in hertz (Hz).

* A non-periodic is one that it does not repeat itself at fixed interval. and may be composed of random or differen pulse with b/w the pulses.

DUTY CYCLE:

the ratio of the pulse width (t_w) to the period (T). (it can be express as percentage)

$$\text{Duty cycle} = \left(\frac{t_w}{T}\right) \times 100\%$$

Q1 **Ex 1.1:**

a) T is 10ms, after the value 10 the same t is repeating itself

b) $f = \frac{1}{T} = \frac{1}{10} = 0.1\,\text{ms} \overset{\times 1000}{\approx} 100\,\text{Hz}$ { 10^3 millisec, 1000 Sec

c) Duty cycle $= \left(\frac{1\,\text{ms}}{10\,\text{ms}}\right) \times 100\% = 10\%$ (0.1 × 100 = 10)

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Q2 $f = \frac{1}{T} = \frac{1ms}{150ms} = 6.66$ $150^3 ms$

Duty cycle = $\left(\frac{25\mu s}{150\mu s}\right) 100\% = 16.66\%$

∴ Each bit in a sequence define time interval is called a bit time.

THE CLOCK :

In digital systems, all waveforms are happened with a basic timing waveform called the clock.

The clock is peradic waveform which is interval b/w pulse is equal ~~for~~ to the time for one bit.

* In this case each change in level waveform occurs at the leading edge of clock waveform.

* In other case each change in level occurs & trailing edge of the clock.

with High & low representation.

y: _____ Date: _____

It only contain binary information

TIMING DIAGRAM:

A time diagram is a graph of digital waveforms which showing the actual time relationship of two or more waveform.

figure 1.12:

The diagram is made up of 4 waveform. where the three waveform A, B & C are HIGH only during bit time 7 (shadded area) and they all change back low at the end of bit time 7

DATA TRANSFER:

A Group of bits that convery some type of information is called data.

Binary data are present in digital waveforms, which must be transferred from one device to another device with in a digital system or from one system to another in order to given purpose.

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* Serial transfer:

When bit transfer in serial from 1 point to another, they are sent one bit at a single time. During the time interval t_0 to t_1, the first bit transfer all eight bits in series take eight time interval.

* Parallel transfer:

When bit is transferred in parallel form, all bits are sent seperate line at the same time. One line for each bit. To transfer 8 bits it take one time interval in parallel.

Ex 1.2:

Q.1

a) f is 1 MHz

$$T = \frac{1}{f} = \frac{1}{1\text{MHz}} \Rightarrow 1\mu$$

It takes 1 μs/bit for 8 #bits

$$8 \times 1\mu s = 8\mu s$$

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The sequence of bits examine the wave form. If waveform A is HIGH during bit time, 1 is transferred. if waveform A is LOW during bit time, 0 is transferred.

b) A parallel take 1μs for all eight bits.

Q2 Time = ?

No. of bits = 16 bits

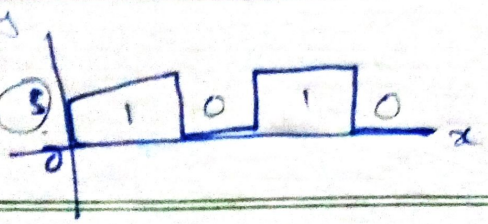
Data rate = 480 million.

Time = no. of bits / Data rate

Time = 16 / 480000000

Time = 3.33×10^{-8} Sec.

It approx take 3.33×10^{-8} Sec to serially transfer 16 bits at a rate of 480 million. per bit per second.



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DECIMAL NUMBER:

Q 4125

in decimal

$4\times10^3 + 1\times10^2 + 2\times10^1 + 5\times10^0$

$4000 + 100 + 20 + 5$

4125

Q 4125.598

$4\times10^3 + 1\times10^2 + 2\times10^1 + 5\times10^0 + 5\times10^{-1} + 9\times10^{-2} + 8\times10^{-3}$

$4000 + 1000 + 20 + 5 + 0.5 + 0.09 + 0.0008$

4125.598

BINARY NUMBER:

Formula: $2^n - 1$

$2^4 - 1 \Rightarrow 15$

	8	4	2	1	
15 =	1	1	1	1	= 15

A	B	C	D	E	F
10	11	12	13	14	15

2.1 => leave

ay:_____ Date:_____

in decimal

msb LSB msb LSB

101010.0101

$2x1^3 + 0x2^2 + 1x2^1 + 0^0x2 + 0x2^{-1} + 1x2^{-2} + 0x2^{-3} + 1x2^{-4}$

$8 + 4 + 2 + 1 + 0.5 + 0.25 + 0125 + 0.625$

$(109.6875)_{10}$

DECIMAL TO BINARY CONVERSION:

Sum of weight.

$12 = 8 + 4 \quad (1100)_2$

$58 = 32 + 16 + 8 + 2 \quad (111010)_2$

32
16
8
2

$82 = 64 + 16 + 2 \quad (1\,0\,1\,0\,0\,1\,0)_2$

OR

$12/2 = 6 \rightarrow 0$ (lsb) $\quad (1100)_2$

$6/2 = 3 \rightarrow 0$

$3/2 = 1 \rightarrow 1$

$1/2 = 0 \rightarrow 1$ (msb)

if power is even = 0

if power is odd = 1

In decimal value the msb is 2^{-1} & lsb 2^{-n}

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in decimal we multiply value

we start x by 2 from eqv

BINARY ADDITION:

0 + 0 = 0
0 + 1 = 1
1 + 0 = 1
1 + 1 = 0 with carry 1

1+1=0
0+1=1 + 1 1 → 3 (2+1=3)
1 1 → 2+1=3
1 1 0 — 4+2+1 = 6

BINARY NO SUBSTRACTION:

0 - 0 = 0
1 - 0 = 1
1 - 1 = 0
0 - 1 = 1 with a borrow of 1

4 2 1

0 0
1 0 0 — 4
- 1 1 1 — -7
not possible 3

1 1 1
- 1 0 0
0 1 1

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```
   4 2 1
   1 1
   1 1 1   ---> 7
 + 1 1     ---> 3
 ---------
 1 0 1 0         10
 8 4 2 1
```

Addition

```
   1
   1 0 1  ---> 5
 - 0 1 1  ---> 3
 ---------
   0 1 0       2
```