



SNS COLLEGE OF TECHNOLOGY

Coimbatore-35
An Autonomous Institution



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Approved by AICTE, New Delhi & Affiliated to Anna University, Chennai

DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

19ECB204 – LINEAR AND DIGITAL CIRCUITS

II YEAR/ III SEMESTER

DAC /16ECB204-
LDC/Dr.B.Sivasankari,
ASP/ECE/SNSCT

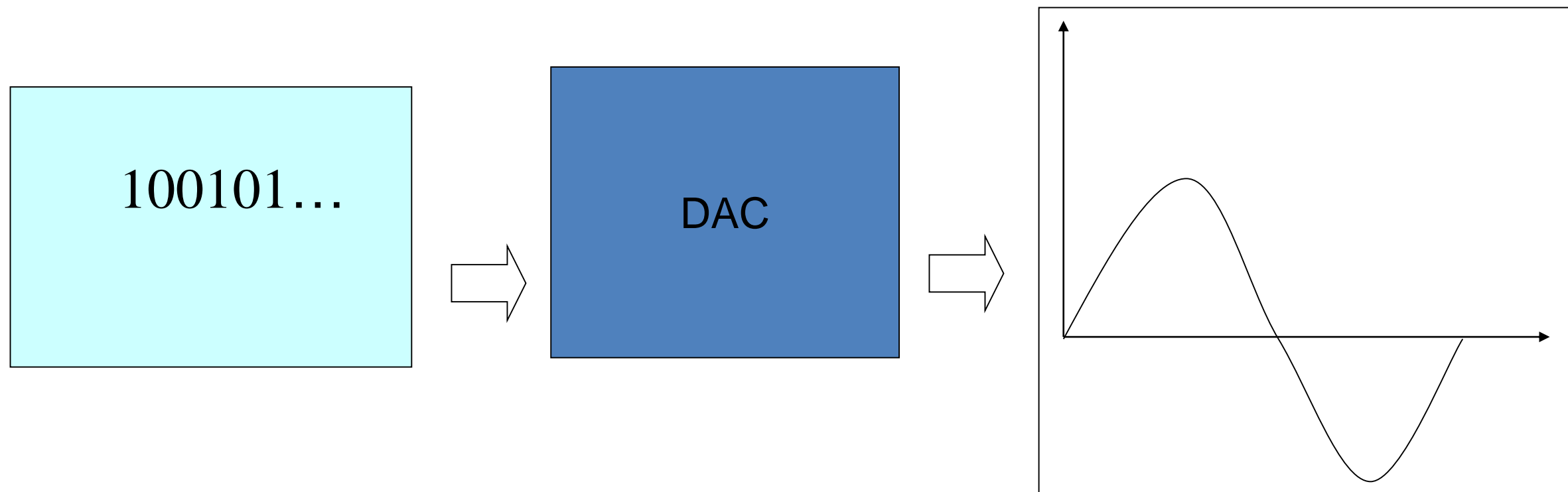
10/12/2022

UNIT 2 – COMPARATORS AND SPECIAL FUNCTION IC's

TOPIC 6 – D/A converter – specifications



WHAT IS A DAC?



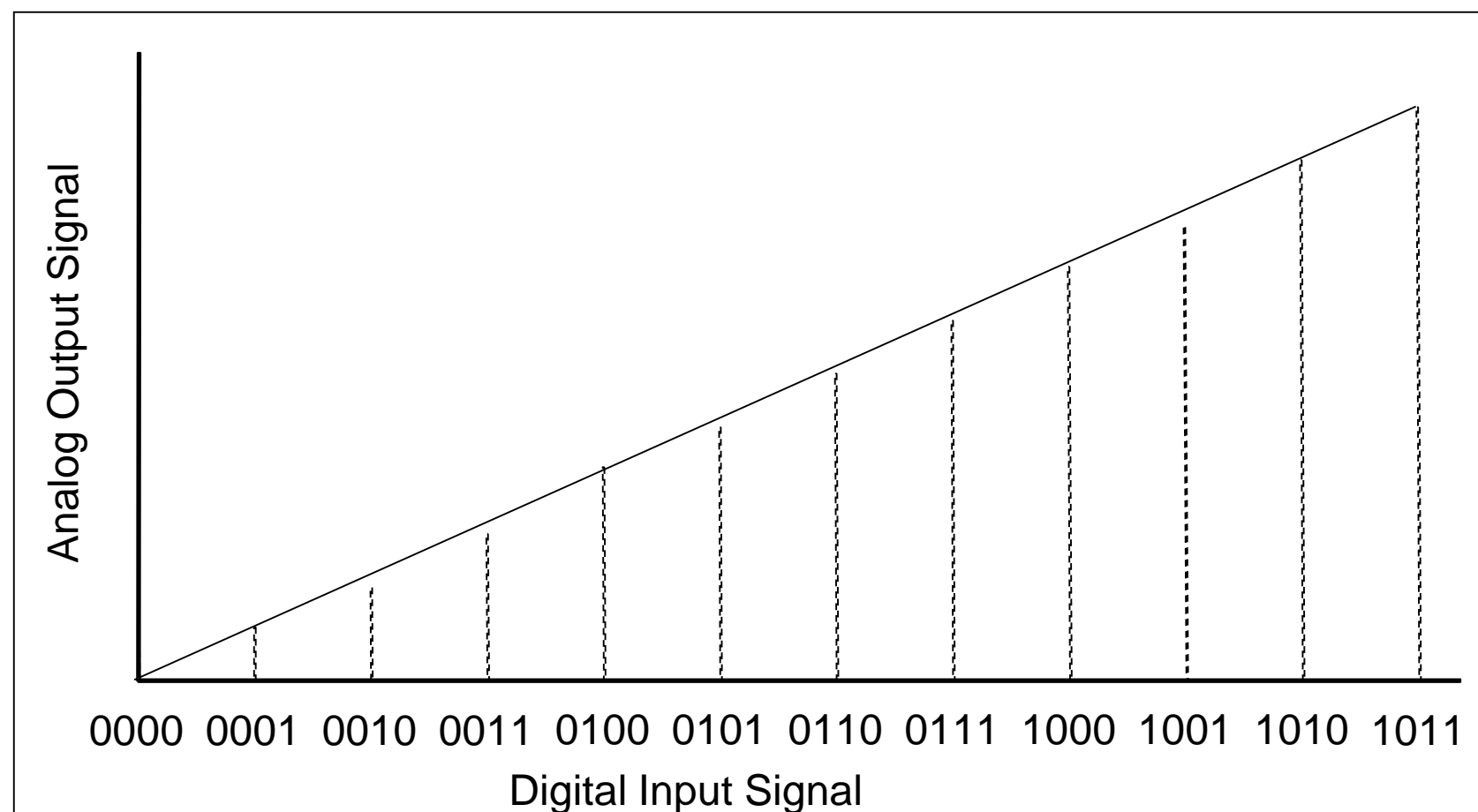
- A Digital-to-analog converter(DAC) takes a digital code as its input and produce an analog voltage or current as its output
- This analog output is proportional to the digital input



DAC



- n digital input for digital encoding.
- Analog input for V_{max} .
- Analog output a .





SPECIFICATIONS OF DAC



- Resolution
- Speed
- Linearity
- Settling Time
- Reference Voltages
- Errors



RESOLUTION



- Smallest analog increment corresponding to 1 LSB change
- An N-bit resolution can resolve 2^N distinct analog levels
- Common DAC has a 8-16 bit resolution



SPEED



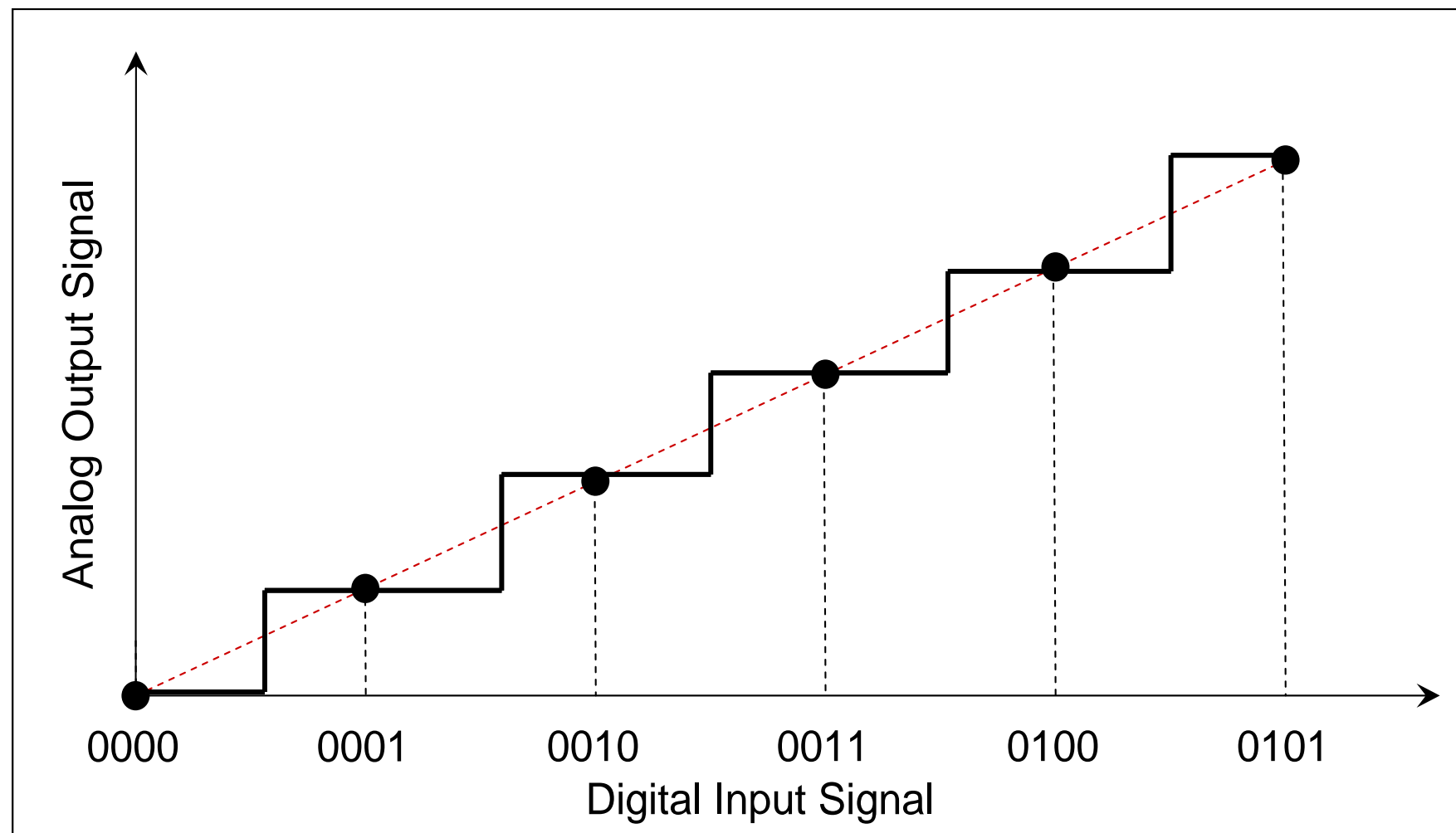
- Rate of conversion of a single digital input to its analog equivalent
- Conversion rate depends on
 - ✓ clock speed of input signal
 - ✓ settling time of converter
- When the input changes rapidly, the DAC conversion speed must be high.



LINEARITY



- The difference between the desired analog output and the actual output over the full range of expected values

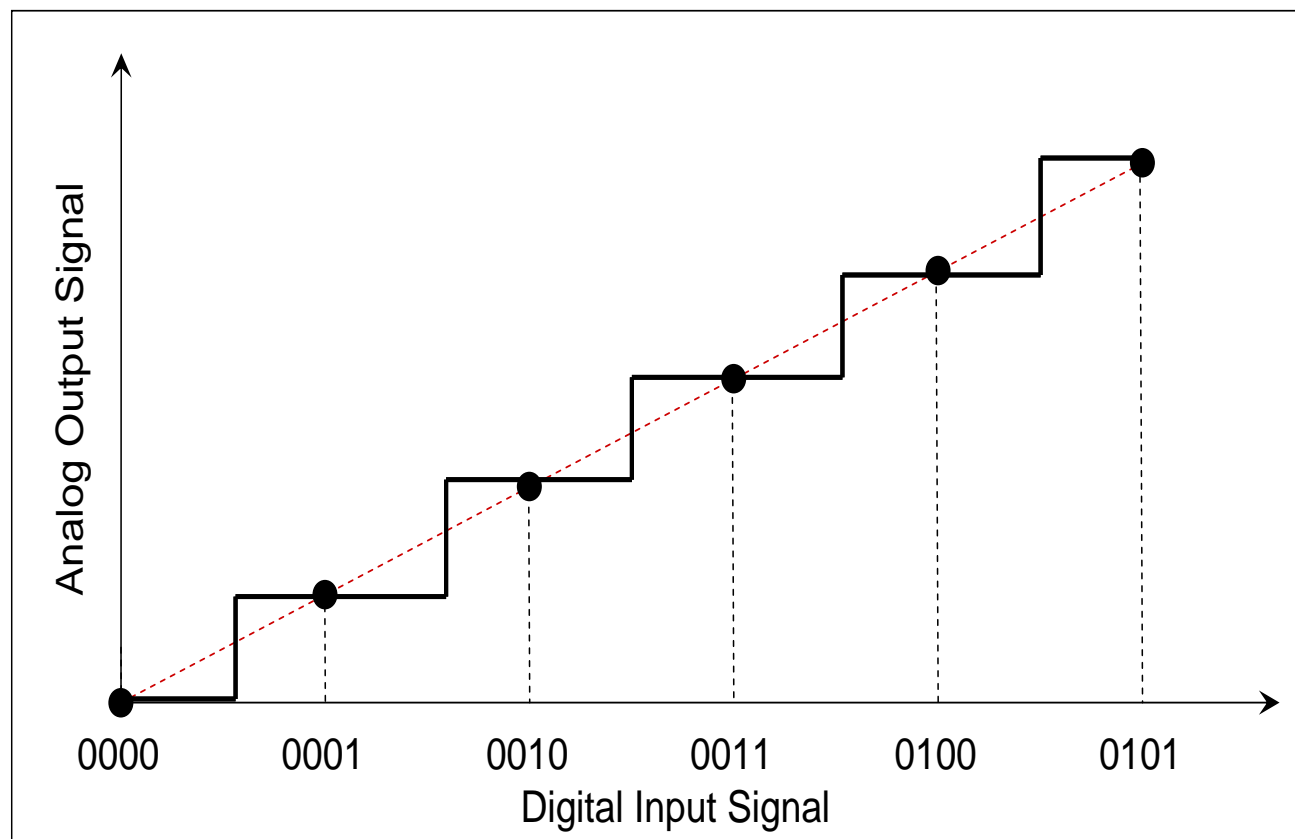




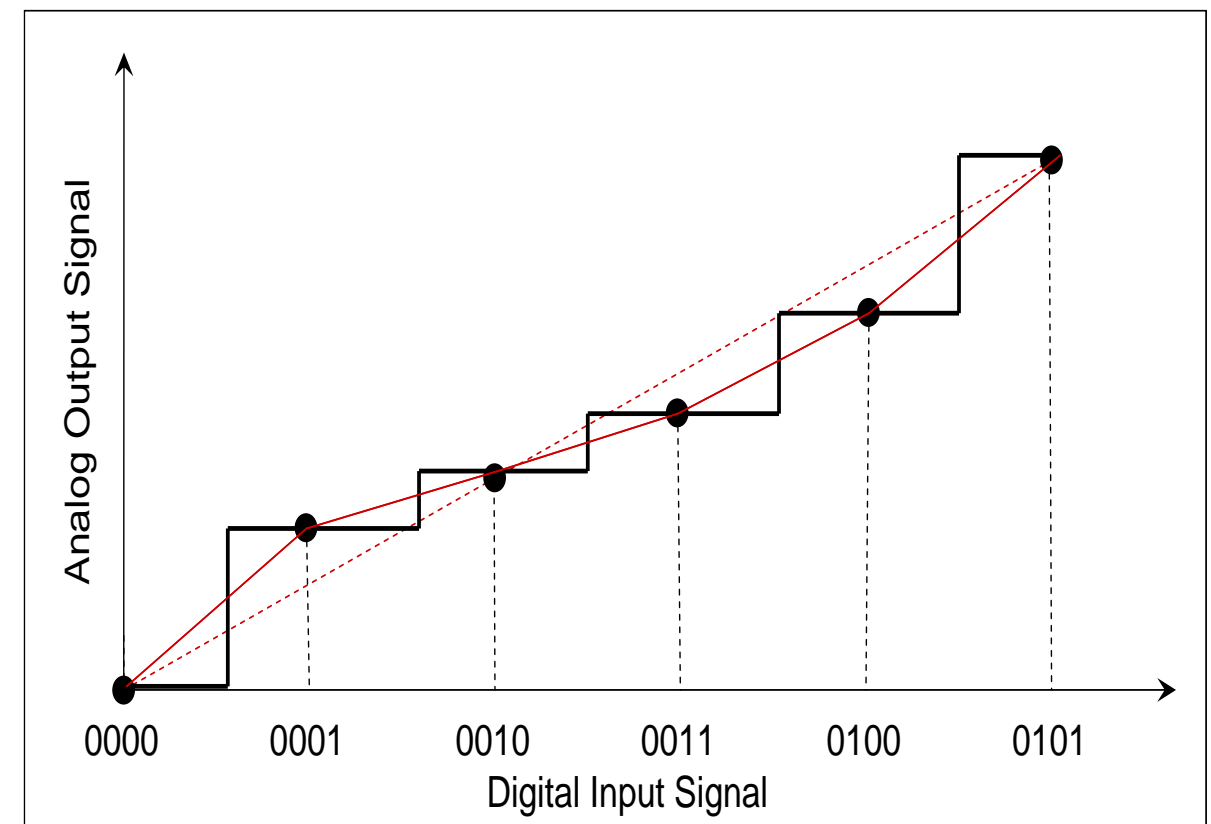
LINEARITY



- Ideally, a DAC should produce a linear relationship between the digital input and analog output



Linearity (Ideal)



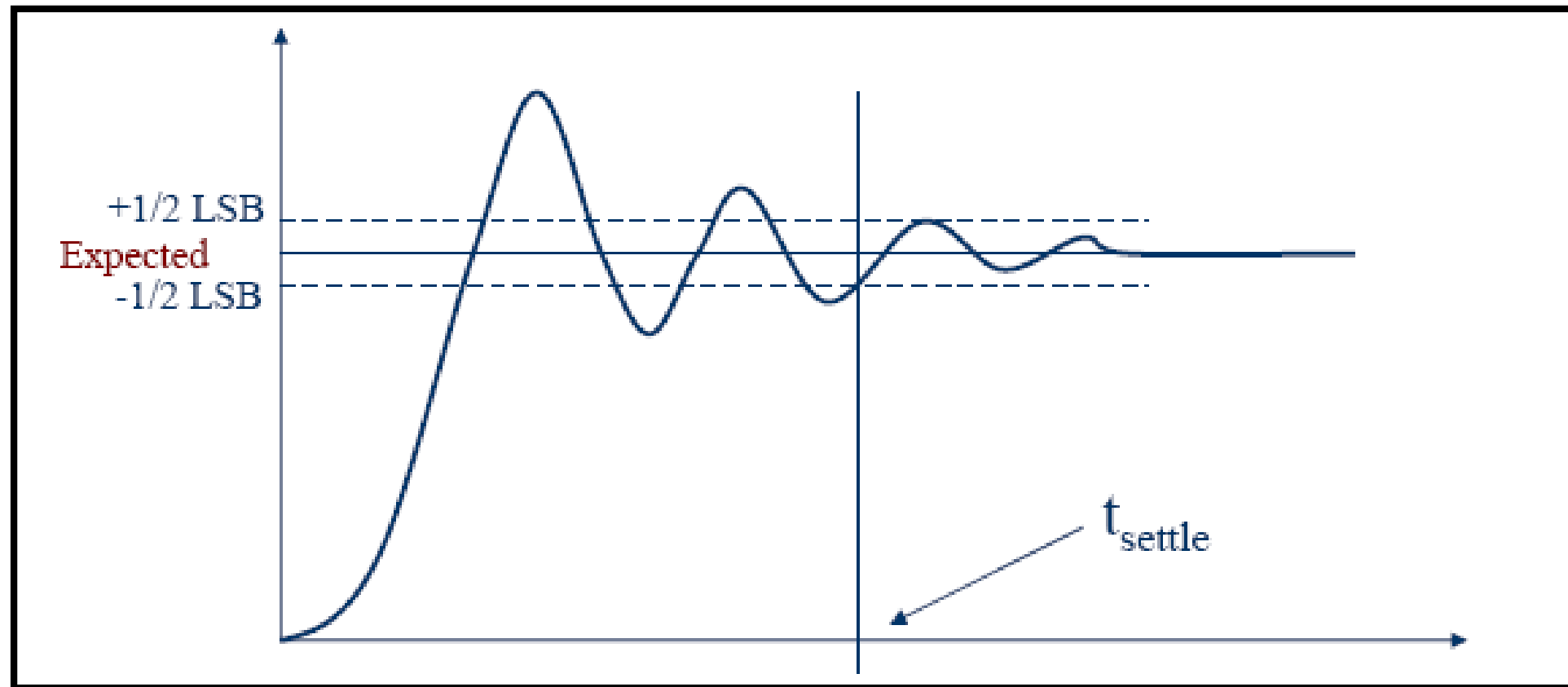
Non-Linearity



SETTLING TIME



- Time required for the output signal to settle within $\pm 1/2$ LSB of its final value after a given change in input scale
- Limited by slew rate of output amplifier
- Ideally, an instantaneous change in analog voltage would occur when a new binary word enters into DAC





REFERENCE VOLTAGES



- Used to determine how each digital input will be assigned to each voltage division
- Types:
 - Non-multiplier DAC: V_{ref} is fixed
 - Multiplier DAC: V_{ref} provided by external source



Activity



Odd or Even?

Name: _____

Directions: Cut out numbers. Sort them into even or odd. Glue in the correct box.

Odd

Even



© First Grade Brain

7	54	28	53	16	42	105	75
11	38	91	100	89	64	33	86



TYPES OF ERRORS ASSOCIATED WITH DACS



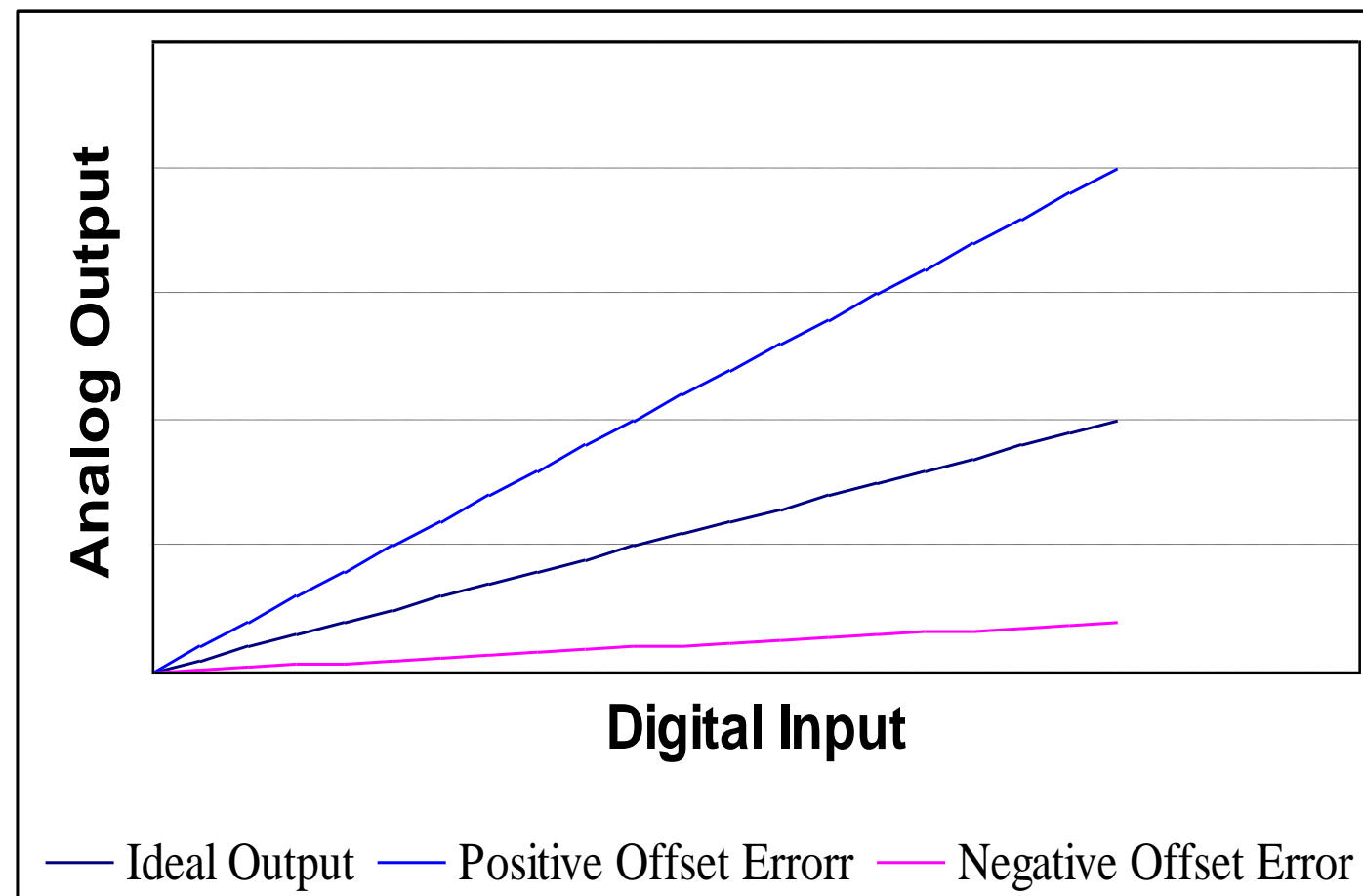
- Gain
- Offset
- Full Scale
- Resolution
- Non-Linearity
- Non-Monotonic
- Settling Time and Overshoot



GAIN ERROR



- Occurs when the slope of the actual output deviates from the ideal output

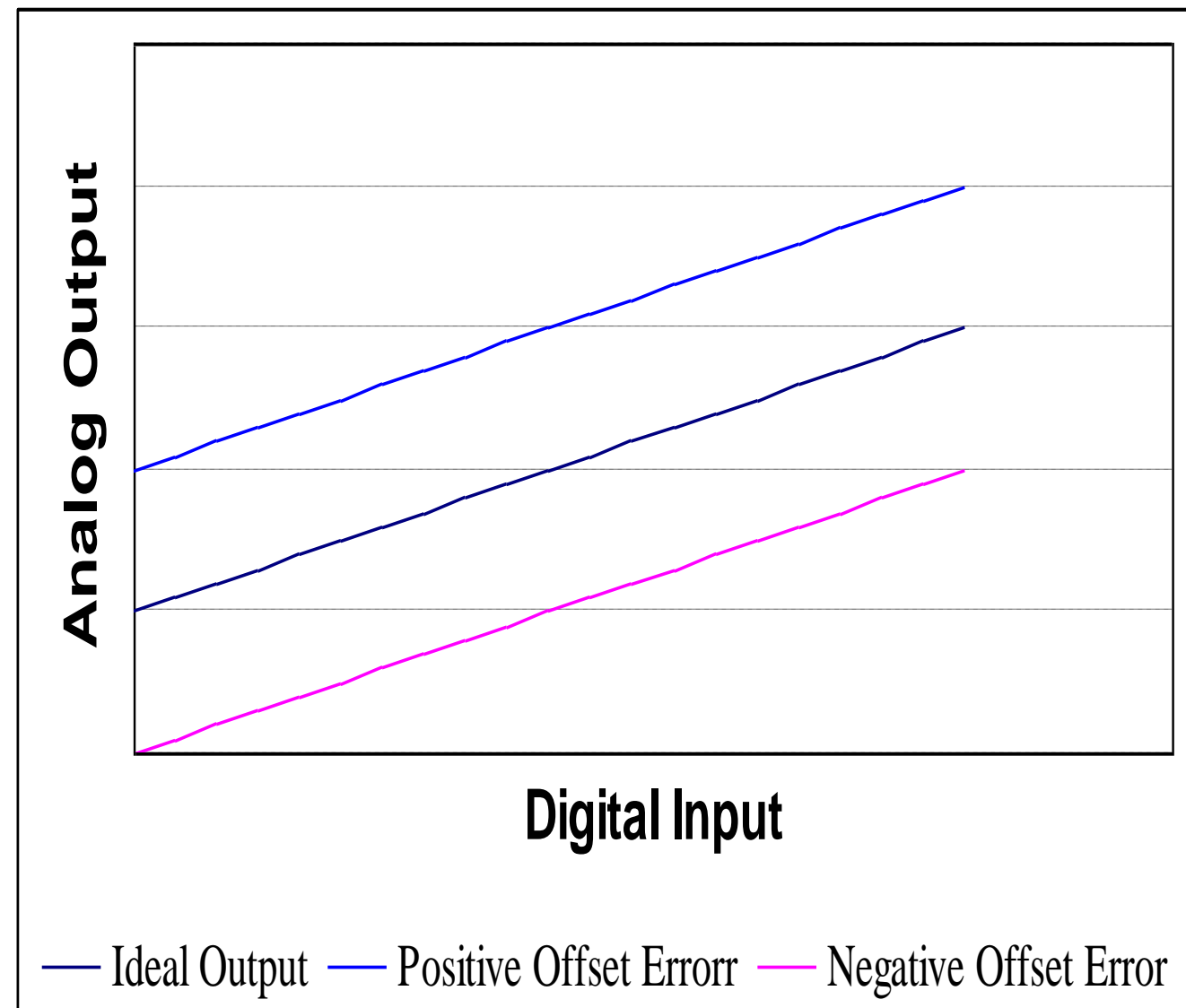




OFFSET ERROR

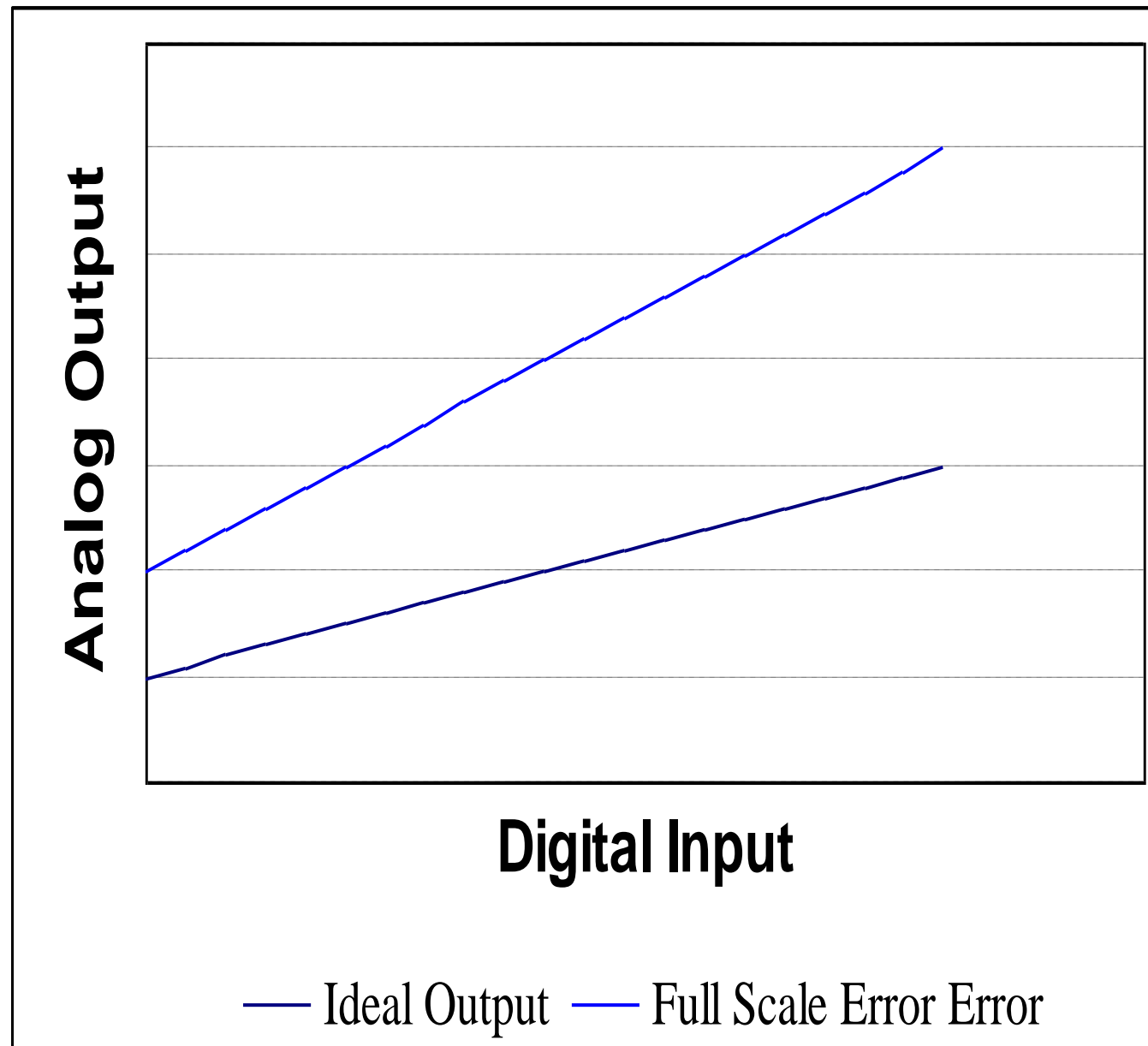


- Occurs when there is a constant offset between the actual output and the ideal output C





FULL SCALE ERROR



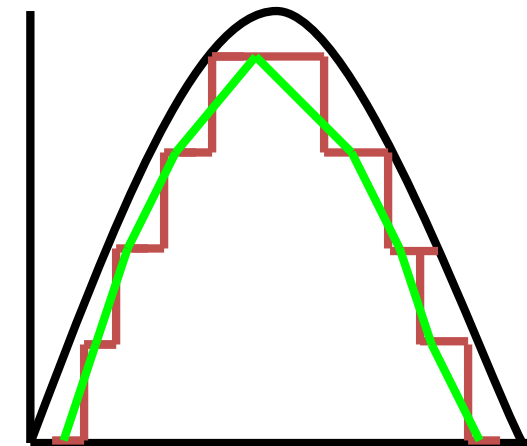
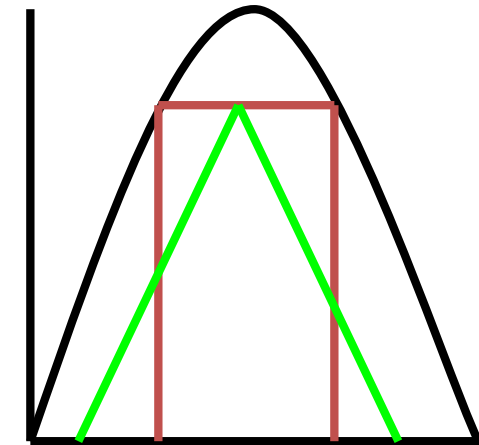
- Occurs when the actual signal has both gain and offset errors



RESOLUTION ERROR



- Poor representation of ideal output due to poor resolution
- Size of voltage divisions affect the resolution

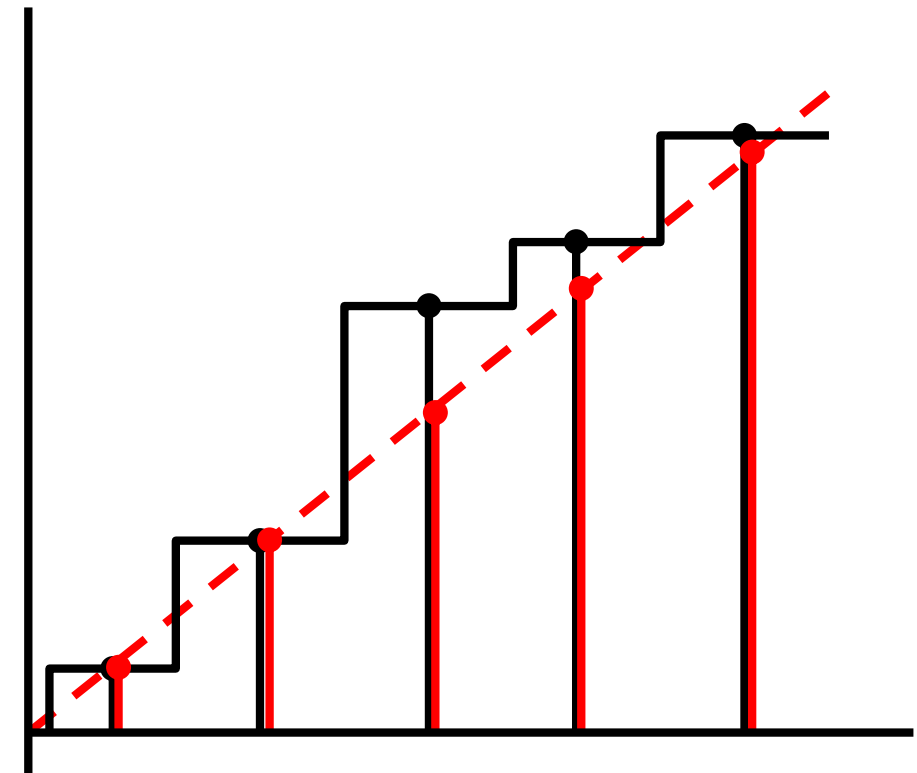




NON-LINEARITY ERROR

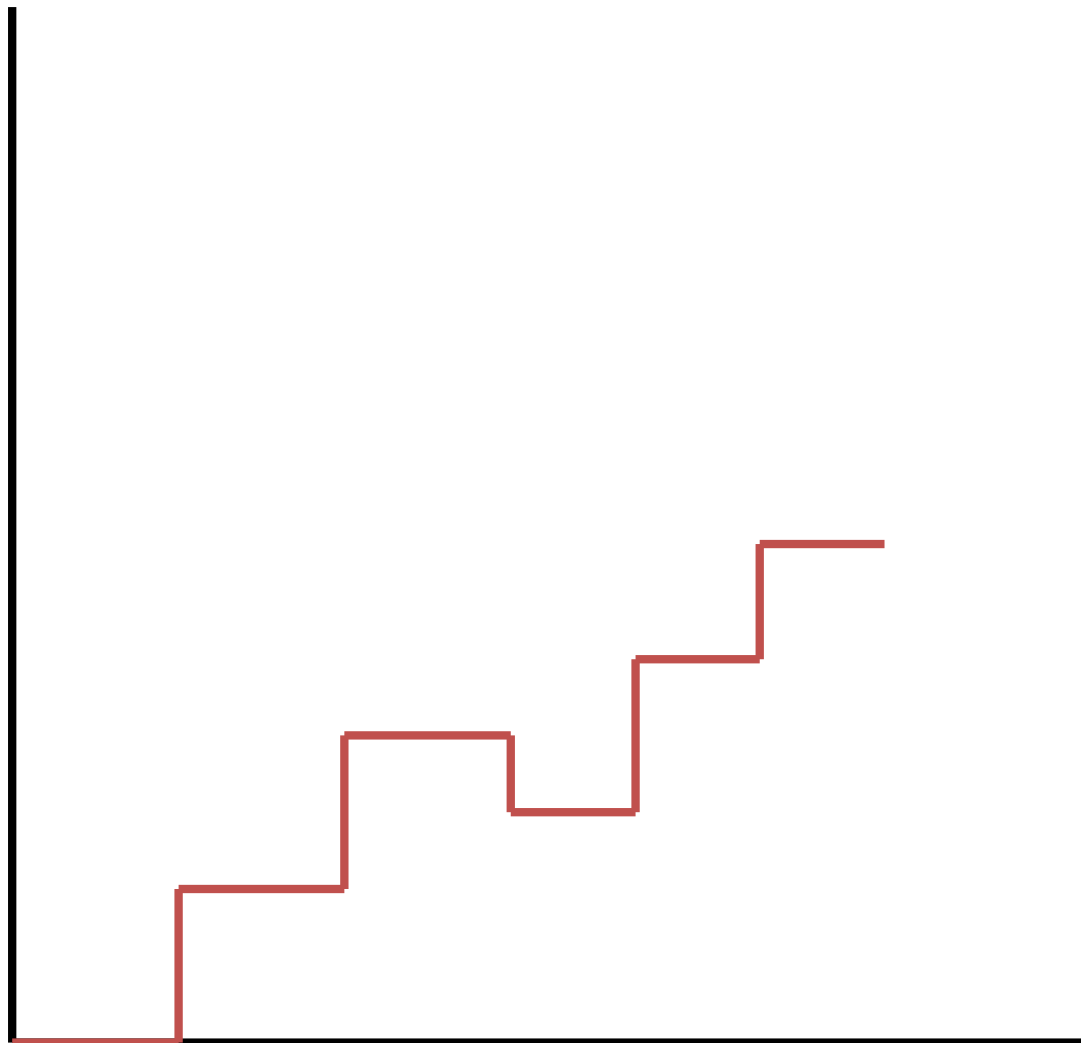


- Occurs when analog output of signal is non-linear
- Two Types
 - Differential – analog step-sizes changes with increasing digital input (measure of largest deviation; between successive bits)
 - Integral – amount of deviation from a straight line after offset and gain errors removed; on concurrent bits





NON-MONOTONIC ERROR



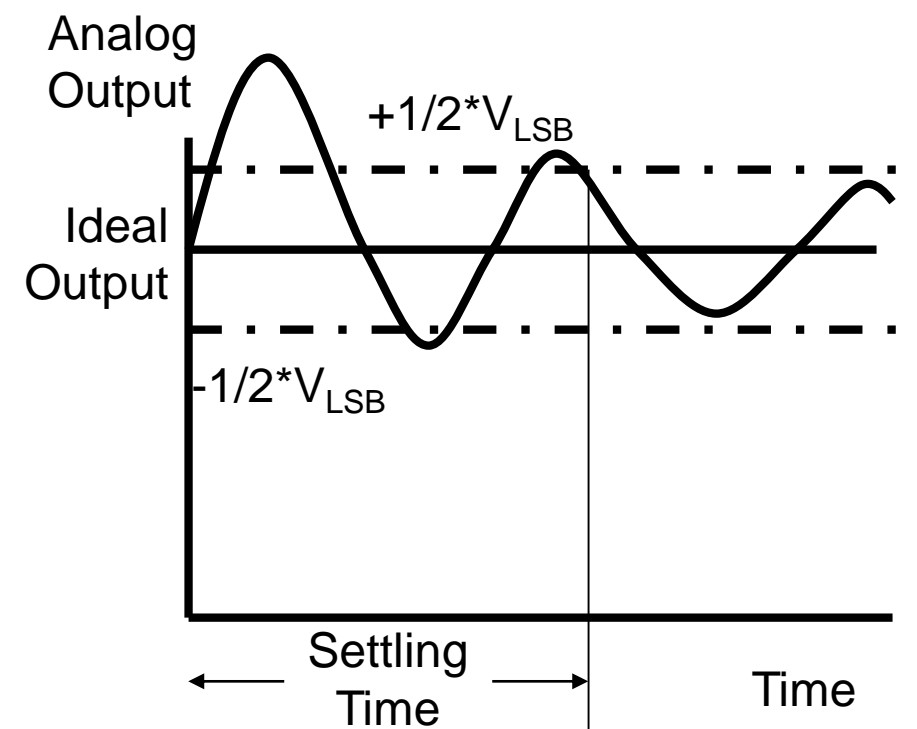
- Occurs when an increase in digital input results in a decrease in the analog output



SETTLING TIME AND OVERSHOOT ERROR



- Settling Time – time required for the output to fall within $\pm 1/2 V_{LSB}$
- Overshoot – occurs when analog output overshoots the ideal output





APPLICATIONS



- Digital Motor Control
- Computer Printers
- Sound Equipment (e.g. CD/MP3
Players, etc.)





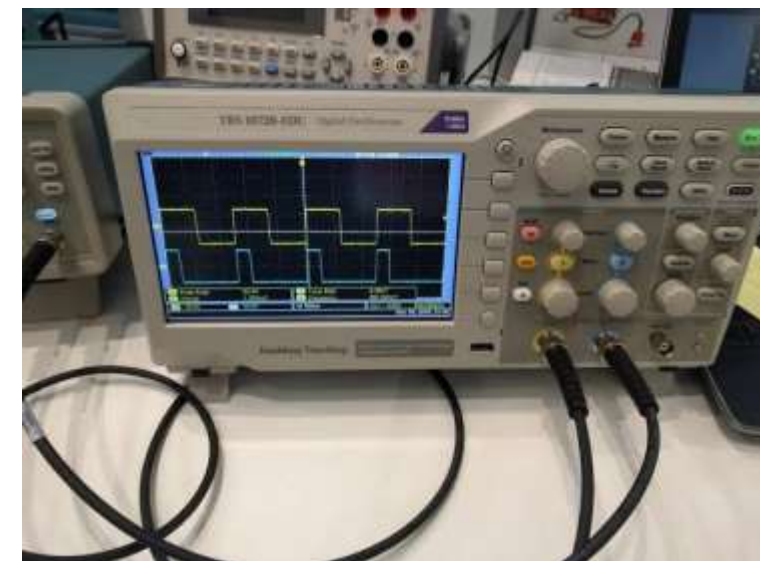
APPLICATIONS



■ Digital Oscilloscopes



■ Signal Generators





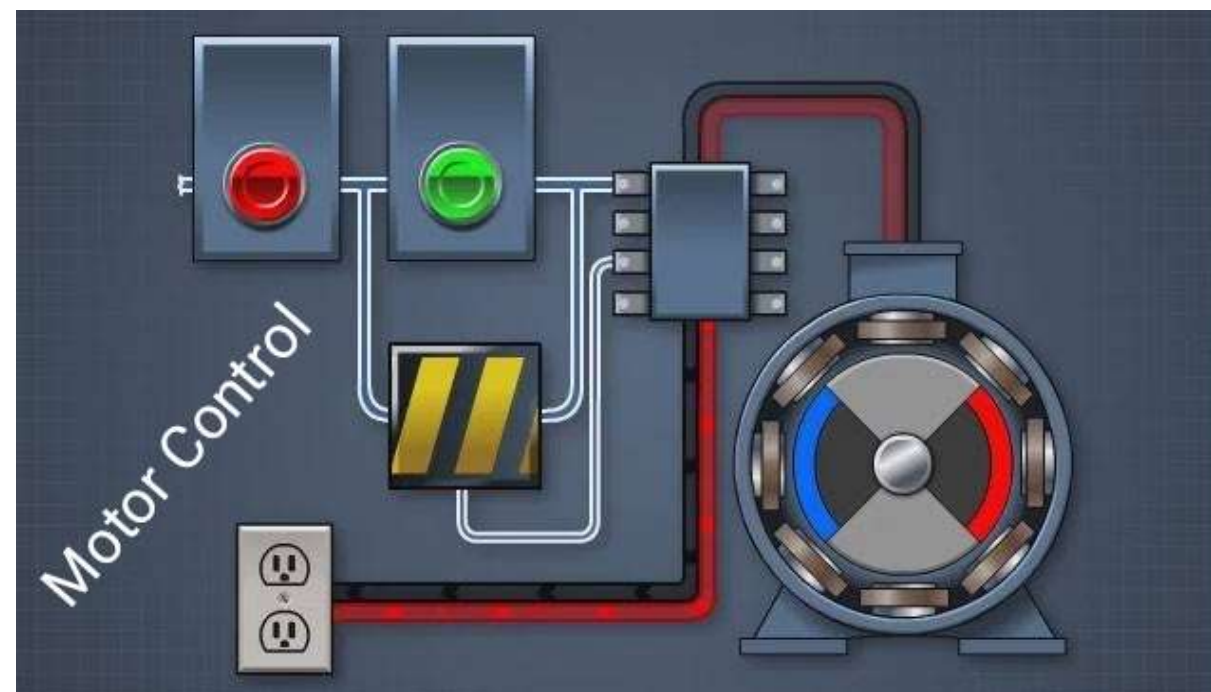
APPLICATIONS



- Motor controllers



Cruise Control



Motor Control



Valve Control



Assessment



1. What is the purpose of a Digital-to-Analog converter?
2. Function of digital-to-analog converter circuit is ---





THANK YOU