# SNS COLLEGE OF TECHNOLOGY

**(An Autonomous Institution)**

**COIMBATORE-35**

**Accredited by NBA-AICTE and Accredited by NAAC – UGC with A+ Grade**

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

# 19EET208 / DIGITAL ELECTRONICS AND INTEGRATED CIRCUITS

## II YEAR / IV SEMESTER

## UNIT-V: OPERATIONAL AMPLIFIER AND TIMER IC

## DAC TECHNIQUES

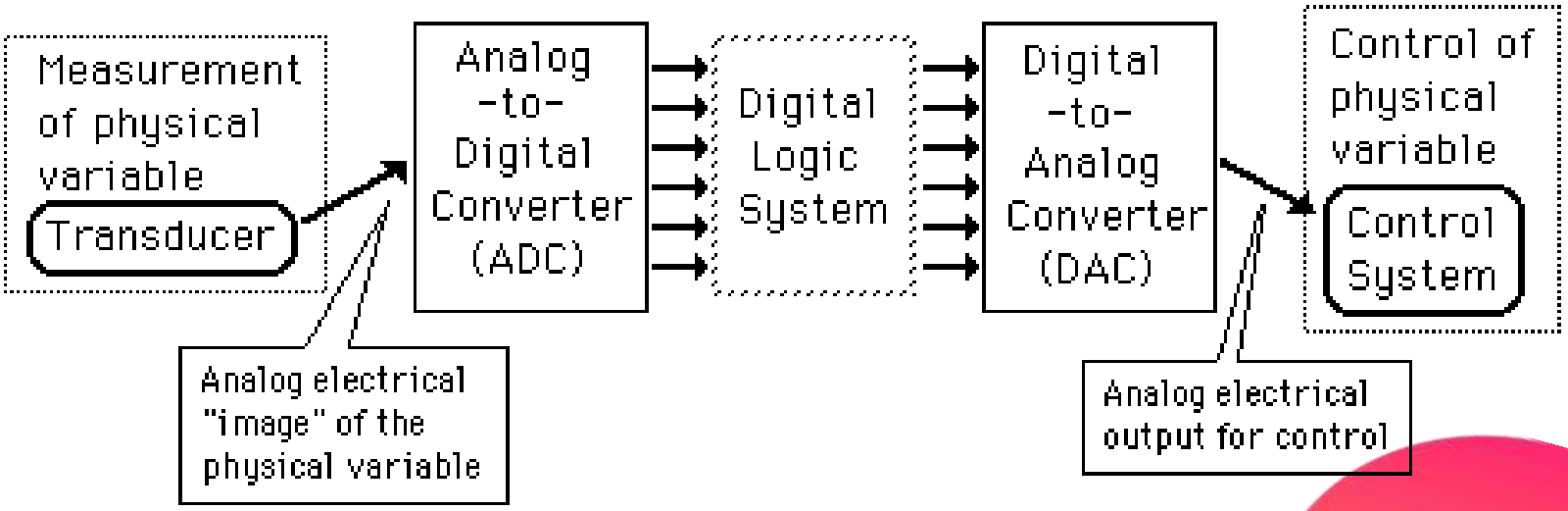
# Topics

- Data Handling Systems
- Data Collection and Control Block
- Digital to Analog Conversion (DAC)
- Weighted summing
- R-2R ladder
- Applications

# Data Handling Systems

- Both data about the physical world and control signals sent to interact with the physical world are typically "analog" or continuously varying quantities.
- In order to use the power of digital electronics, one must convert from analog to digital form on the experimental measurement end and convert from digital to analog form on the control or output end of a laboratory system.

# Data Collection and Control



# Digital-to-Analog Conversion [DAC]

# Digital-to-Analog Conversion

- When data is in binary form, the 0's and 1's may be of several forms such as the TTL form where the logic zero may be a value up to 0.8 volts and the 1 may be a voltage from 2 to 5 volts.
- The data can be converted to clean digital form using gates which are designed to be on or off depending on the value of the incoming signal.

# Digital-to-Analog Conversion

- Data in clean binary digital form can be converted to an analog form by using a summing amplifier.
- For example, a simple 4-bit D/A converter can be made with a four-input summing amplifier.

# Digital-to-Analog Conversion

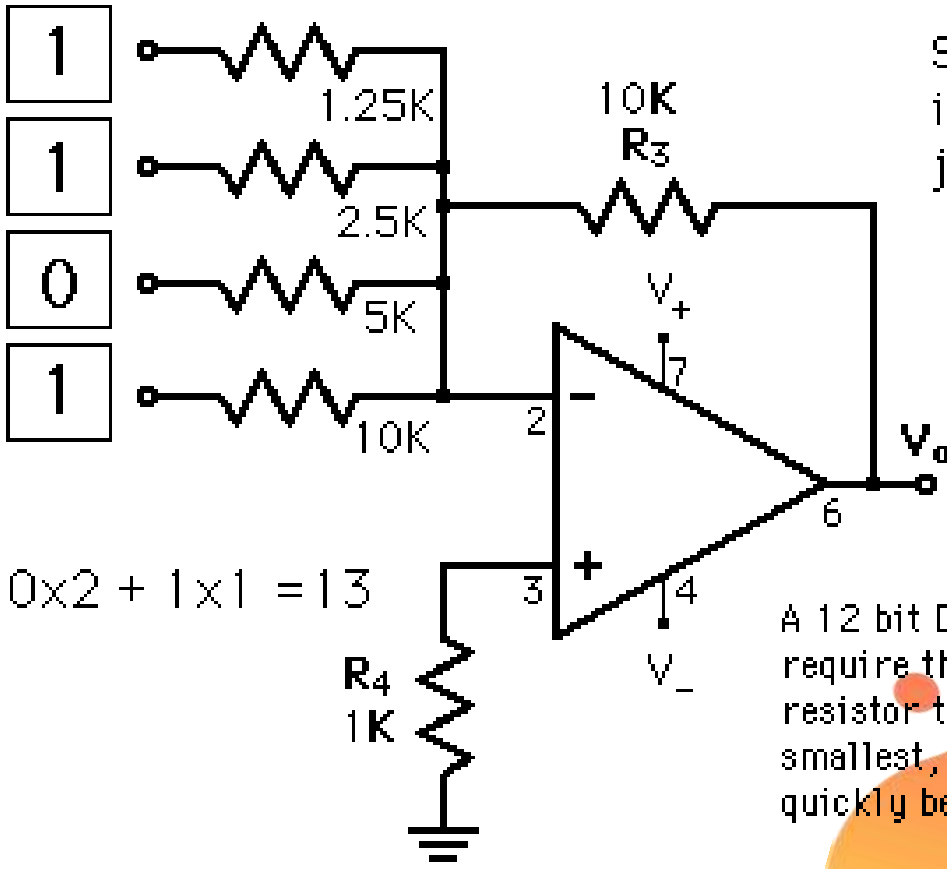
- 2 Basic types
  - Weighted Summing Amplifier
  - R-2R Network Approach

# Weighted Sum DAC

- One way to achieve D/A conversion is to use a summing amplifier.
- This approach is not satisfactory for a large number of bits because it requires too much precision in the summing resistors.
- This problem is overcome in the R-2R network DAC.

# Weighted Sum DAC

Inputs in volts are weighted in the summing amplifier to produce the corresponding analog voltage.

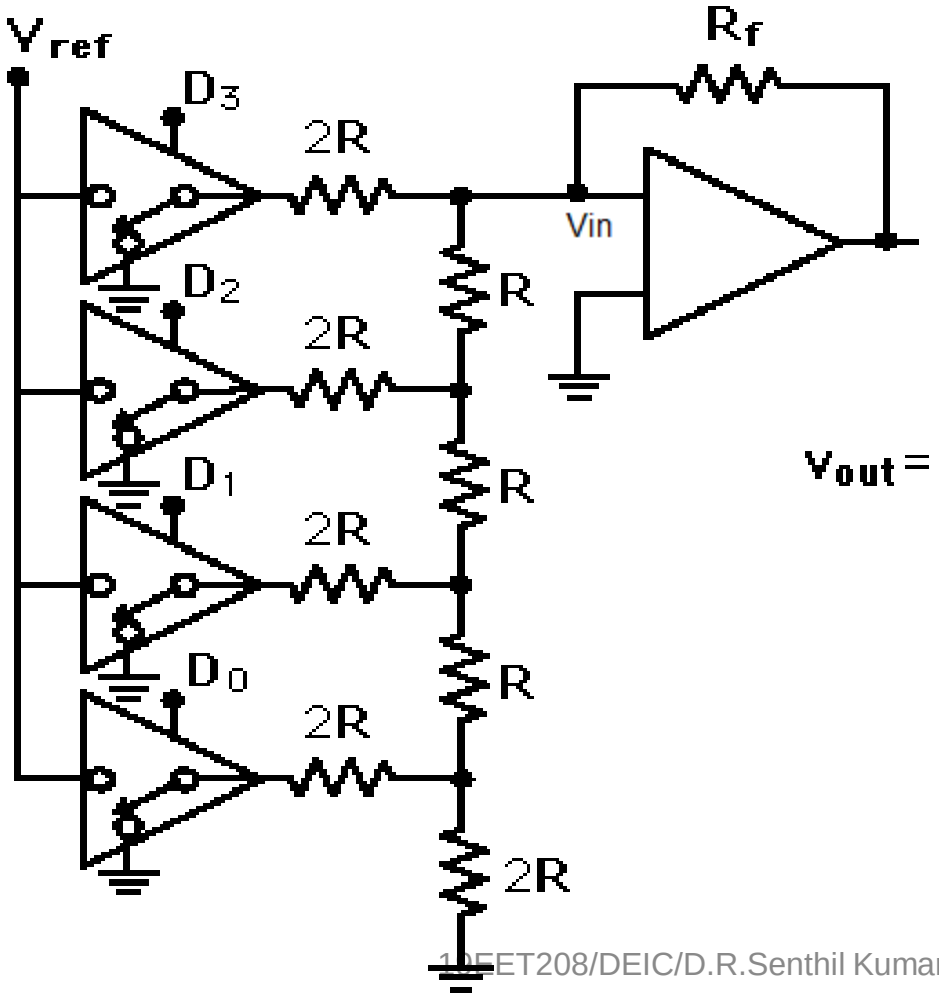



Scaled resistances into a summing junction.

$1x8 + 1x4 + 0x2 + 1x1 = 13$

A 12 bit DAC of this type would require the largest scaling resistor to be 2048 times the smallest, so this approach quickly becomes impractical.

# R-2R Ladder DAC



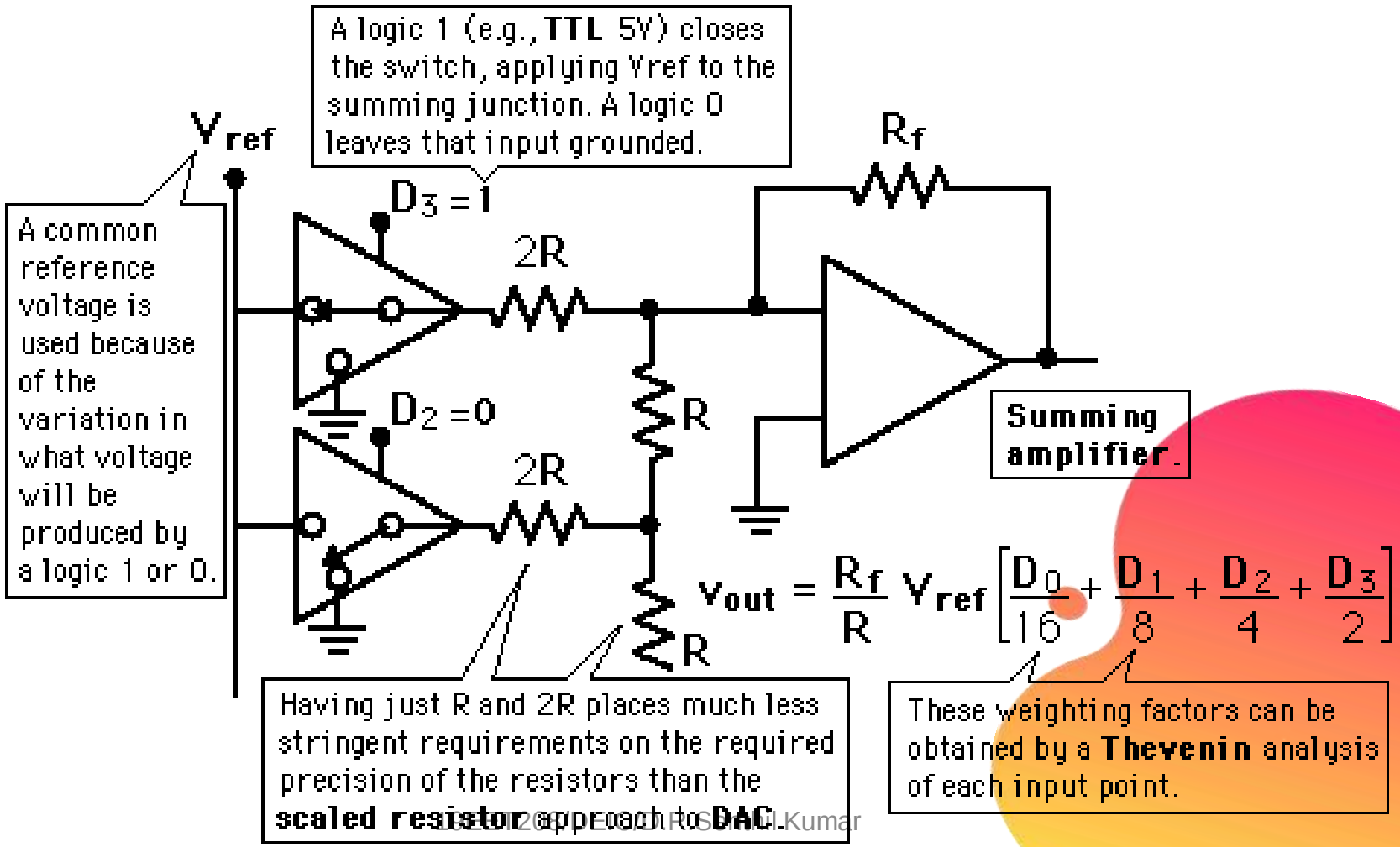

$$V_{ref} = \frac{V_{in} * 2R}{R + R + 2R}$$

Now,

$$V_o = - V_{ref} * R_f$$

$$V_{out} = \frac{R_f}{R} V_{ref} \left[ \frac{D_0}{16} + \frac{D_1}{8} + \frac{D_2}{4} + \frac{D_3}{2} \right]$$

# R-2R Ladder DAC



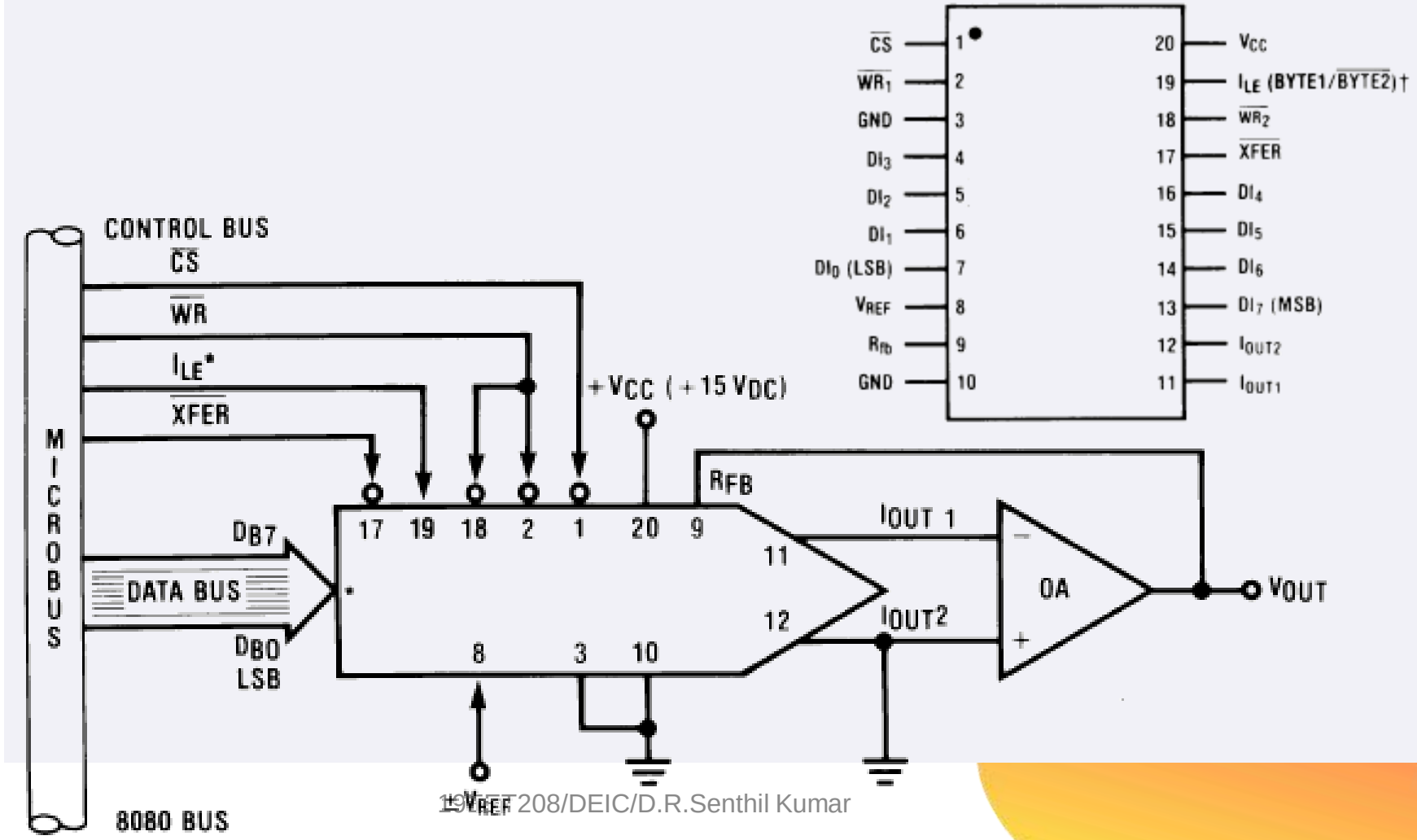
# R-2R Ladder DAC

- The summing amplifier with the R-2R ladder of resistances shown produces the output where the D's take the value 0 or 1.
- The digital inputs could be TTL voltages which close the switches on a logical 1 and leave it grounded for a logical 0.
- This is illustrated for 4 bits, but can be extended to any number with just the resistance values R and 2R.

# DAC0830/DAC0832
# 8-Bit µP Compatible DAC

- An advanced CMOS/Si-Cr 8-bit multiplying DAC designed to interface directly with the 8080, 8048, 8085, Z80®, and other popular microprocessors.
- A deposited silicon-chromium R-2R resistor ladder network divides the reference current and provides the circuit with excellent temperature tracking characteristics (0.05% of Full Scale Range maximum linearity error over temperature).

# Typical Application



# Q & A

Thank You