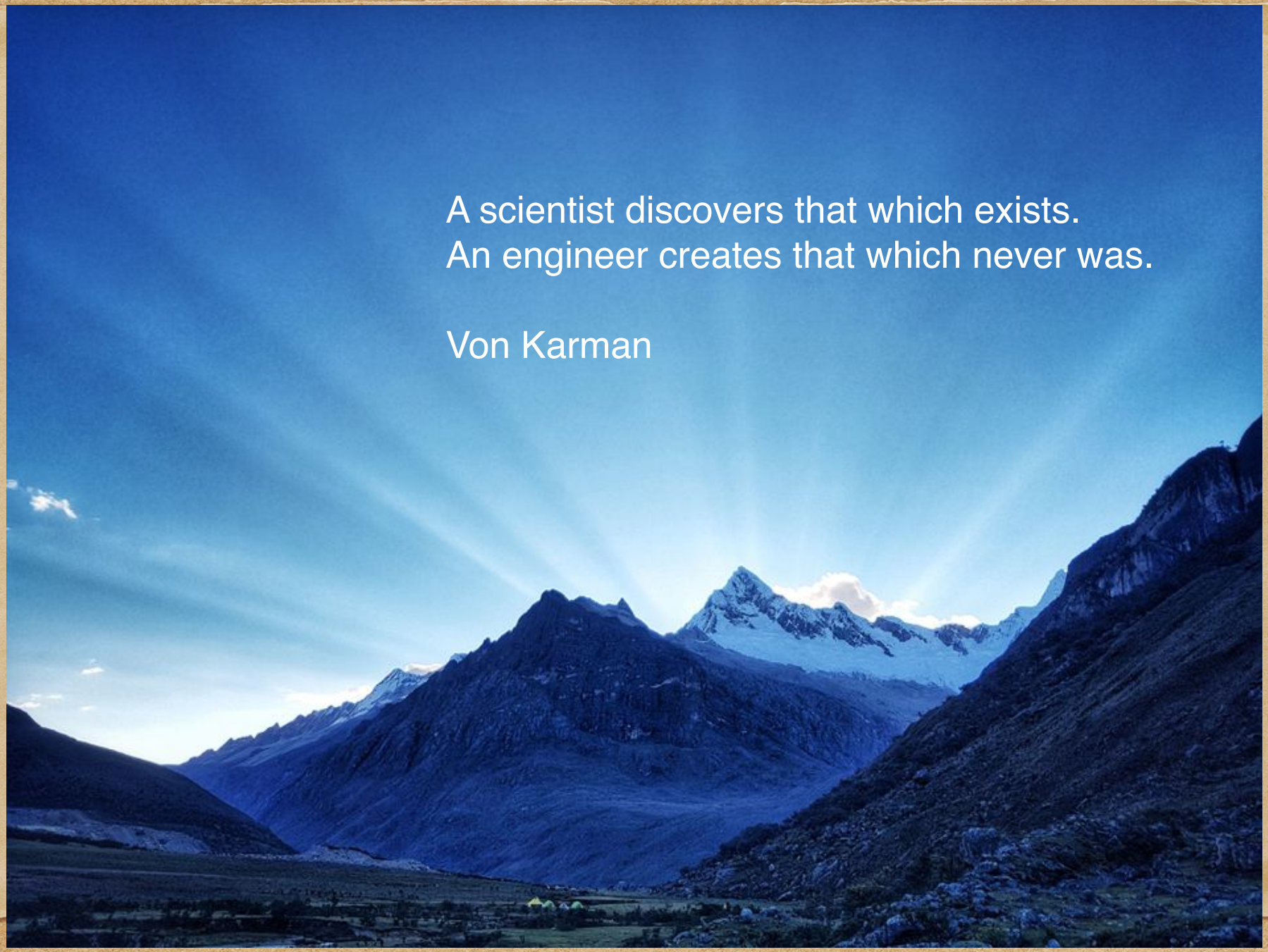
# Digital Logic Design

Lecture No 04: Complements

Fall 2021, BEE-12CD

Dated 20 Sept 2021

**By Nasir Mahmood**
nasir.mahmood@seecs.edu.pk
nasirm15@gmail.com


A scientist discovers that which exists.
An engineer creates that which never was.
Von Karman

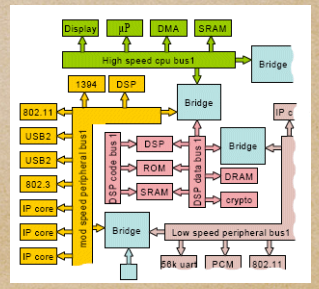
# Components of Academic Success

# My Introduction

- Bachelor of Engineering (Avionics)
  - (January 1982) NED University of Engineering and Technology, Karachi, Pakistan

- Master of Science ( Control, Guidance and Simulation of Flight Vehicles)
  - (October 1997) Beijing University of Aeronautics and Astronautics, China

- PhD Studies Course Work ( Embedded Systems)
  - (Dec 2009) KTH, Royal Institute of Technology, Sweden



# My Experience

- Foreign qualified from USA for computerised testing equipment with over six years experience in setting up of computer based Automated Computer Stations (ATS) facility, management of special training on ATS and maintenance management of sophisticated aircraft electronic systems
- Five years experience in teaching BE students in electronics, digital systems and computer architecture at College of Aeronautical Engineering , Risalpur
- More than Twenty years teaching IT and Electrical Engineering subjects in NUST School of Electrical Engineering and Computer Science (SEECS)

# Lecture Review

- About the Course Title
  - Digital Logic Design
- Motivation for learning the Course
  - Mostly all the devices and systems are digital
  - Lays foundation for Computer Hardware and other computer engineering subjects
- Course Objective and Description
  - Student will be able to design and implement practical logic circuits and do innovative projects
- Text and Reference Books
  - Must read text book and practice more from reference books
- My introduction
  - Aeronautical Engineer serving NUST for the last twenty years, Taught DLD many times

# Review of Previous Learning Outcomes

- What is DLD Course Objective and how Course Learning outcomes are related to OBE PLOs?
- What are the tips to good deeper understanding of subject and attain a good grade?
- What is the basis of any number system?
- How to convert any number system to decimal number system?
- How to convert decimal number system to required base
- Conversion from one number system to another number system?

# Today's Lecture Learning Outcome

- What for Complements are used?
- How to take radix complement (r's) complement?
- How to take diminished radix complement (r-1s) complement?
- Short cuts for taking complements?

# Complements

- Complements are used to simplify subtraction operations. We do subtraction by adding.

  $A - B = A + (-B)$

- There are two types:
  - The radix complement, called the r's complement.
  - The diminished radix complement, called the (r-1)'s complement.

# Diminished Radix Complement or (r-1)'s complement.

- **Given a number N in base r having n digits**
- **The (r - 1)'s complement of N is defined as $(r^n - 1) - N$**
- **For Decimal Number System**
- **9's Complement is = $(10^n - 1) - N$**
- **For example 9's complement of 53406 $= (10^5 - 1) - 53406$**
  **$= 99999 - 53406$ $= 46593$**
- **For Binary Number System**
- **1's Complement is = $(2^n - 1) - N$**
- **For Example 1's complement of 10100110 is $= (2^8 - 1) - 10100110$**
- **$=11111111 - 10100110 = 01011001$**
- Note that 1's complement can be done by switching all 0's to 1's and 1's to 0's

## Finding Diminished Radix Complement (DRC)

- The DRC or (r-1)'s complement of decimal number is obtained by subtracting each digit from 9
- The (r-1)'s complement of octal or hexadecimal number is obtained by subtracting each digit from 7 or F, respectively
- The DRC (1's complement) of a binary number is obtained by subtracting each digit from 1. It can also be formed by changing 1's to 0's and 0's to 1's

# Radix Complement

- The r's complement of an n-digit number N in base-r is defined as:

  $r^n - N$ - for $N \neq 0$

  0 - for $N = 0$

- We may obtain r's complement by adding 1 to (r-1)'s complement. Since $r^n - N = [(r^n - 1) - N]+1$

- 10's complement of 3229 is:

  $10^4 - 3229 = 6771$

- 2's complement of 101101 is:

  $2^6 - 101101 = 010011$

- Note that to determine 2's complement, leave the least significant 0's and the first 1 unchanged and then switch the remaining 1's to 0' and 0's to 1's.

# Notes on Complements

- A couple of notes on complements to keep in mind:
  - If you are trying to determine the complement of a value that contains a radix point:
    - Remove the radix point.
    - Determine the complement.
    - Replace the radix point in the same relative position.
  - The complement of a complement will restore the original number.

# Summary

- Complements?
  - Complements are used for subtraction
- Two Types of Complements?
  - r's Complement
  - r-1's Complement
- Taking 9's Complement? (Decimal number)
  - Subtract every digit from 9
- Taking 1's Complement? (Binary number)
  - Complement every digit, 1 changes to 0 and 0 changes to 1
- Taking 15's Complement? (Hexadecimal number)
  - Subtract every digit from F
- Taking 2's complement
  - Leave the least significant 0's and the first 1 unchanged and then switch the remaining 1's to 0' and 0's to 1's
- Taking 10's Complement? (Decimal number)
  - Leaving least significant zeroes, subtract first non zero digit from 10 and rest from 9

# The End