

# A Course Called Principles of Embedded Systems

What do we learn in this course?

**Nothing!!**

# Principles of Embedded Computing System Design

- 2 Credits Core Course
- Term and Year: Fall (August) 2014
- Instructor : P. G. Poonacha

# Course Outline

- From circuits to programming and computers
- Examples of Embedded Systems
- Embedded system design and Formalisms for design (UML)
- Study of RISC and CISC architectures
- Pipelining Techniques for speed up
- Study of Data Representation : Floating and Fixed point computation
- Register Allocation Problem
- Memory Management Issues
- Operating Systems with Real Time Constraints(RTOS)
- Power Management Techniques
- Scheduling on Multicore Embedded systems

# Understanding Specific Processors

- ARM Processor: A leader in the market
- Signal Processors from TI and ADI: Leaders in the area of Digital Signal processors.
- SHARC Processor from ADI: dominates the floating-point DSP market with exceptional core and memory performance and outstanding I/O throughput.
- Atom processor from Intel - scalable, environmentally responsible and offer System-on-a-chip technology for embedded applications

# References

- Text Book: Computers as Components, Principles of Embedded Computing System Design, Wyne Wolf, Princeton University, Morgan Kauffman Publishers, Academic Press, 2001
- Published material from TI, ADI, ARM, Intel and others

# **A Symbolic Analysis of Relay and Switching Circuits\***

*Claude E. Shannon\*\**

## **I. Introduction**

In the control and protective circuits of complex electrical systems it is frequently necessary to make intricate interconnections of relay contacts and switches. Examples of these circuits occur in automatic telephone exchanges, industrial motor-control equipment, and in almost any circuits designed to perform complex operations automatically. In this paper a mathematical analysis of certain of the properties of such networks will be made. Particular attention will be given to the problem of network synthesis. Given certain characteristics, it is required to find a circuit incorporating these characteristics. The solution of this type of problem is not unique and methods of finding those particular circuits requiring the least number of relay contacts and switch blades will be studied. Methods will also be described for finding any number of circuits equivalent to a given circuit in all operating characteristics. It will be shown that several of the well-known theorems on impedance networks have roughly analogous theorems in relay circuits. Notable among these are the delta-wye and star-mesh transformations, and the duality theorem.

Reading Assignment for this week : There will be a test on Monday (11<sup>th</sup>)

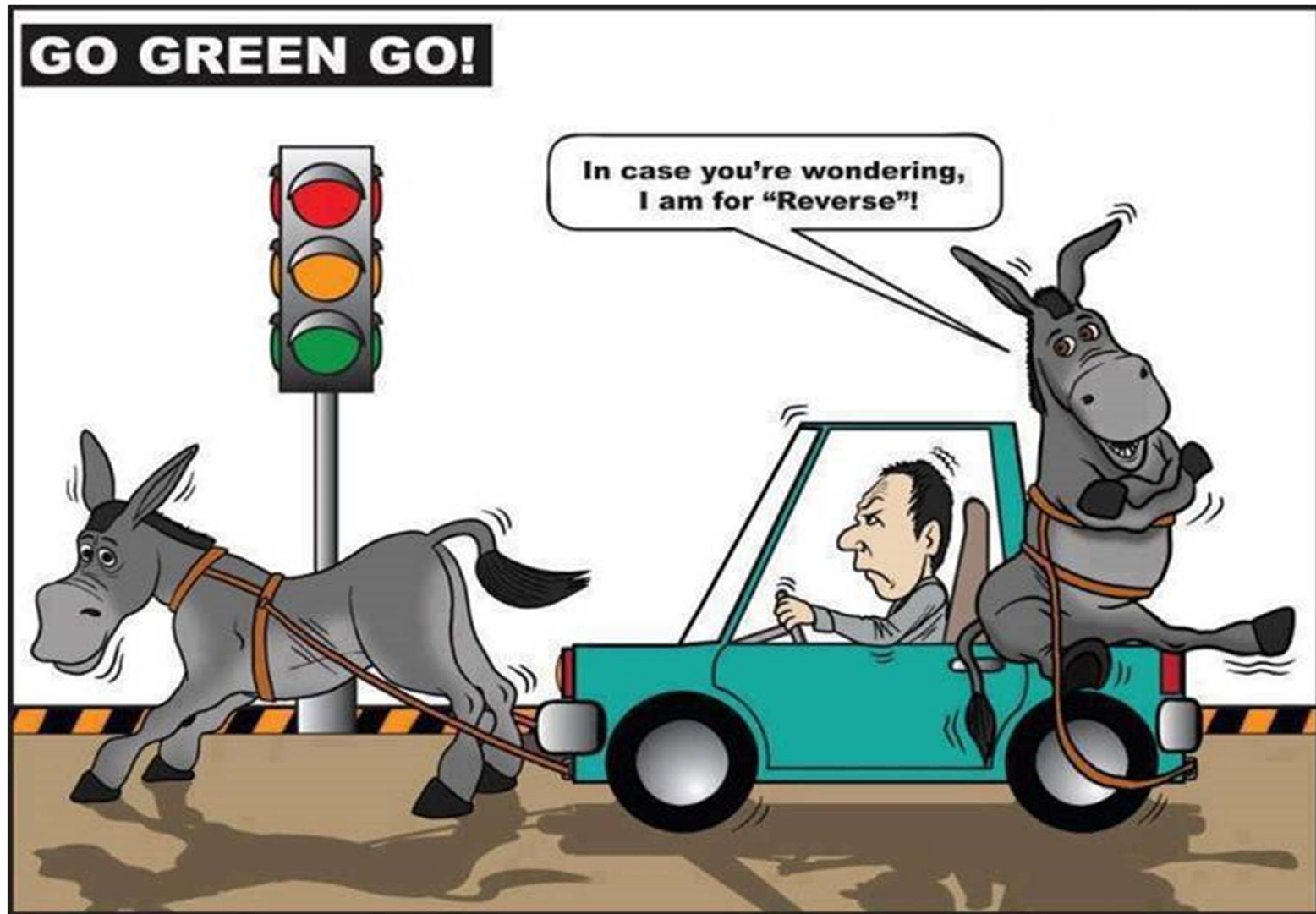
# Fascinating World of Embedded Systems

It is believed that embedded systems with computational intelligence will soon become ubiquitous and change the world forever.

Embedded System consists of sensors, an electronic circuit and a computer which works with real time constraints

Embedded system is a computer with lot of realistic constraints!

# Example of a smart System?





How do we do this?



Is this fake?



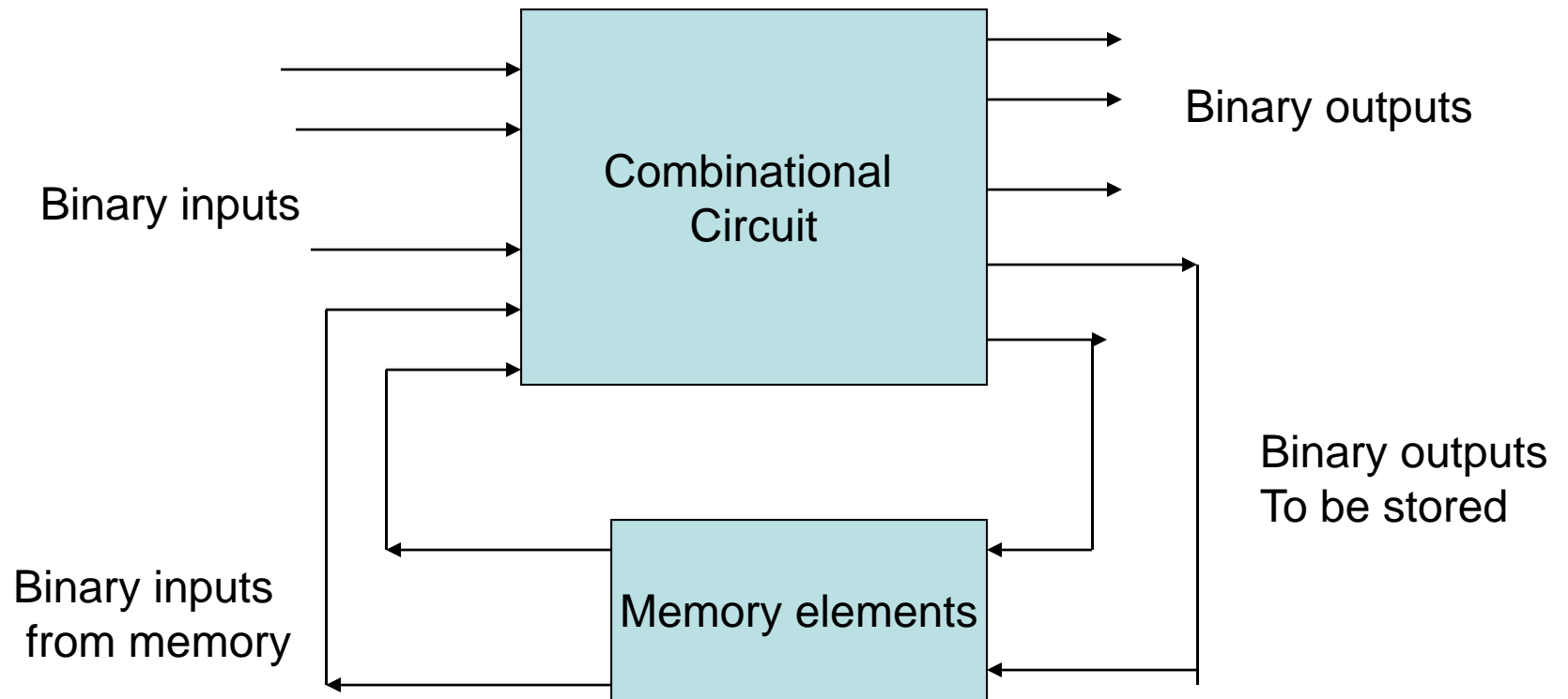
## Limitations of Analog Circuits?

- Analog circuits as of now are not suitable for embedded system design due to tolerance problems leading to errors in outputs.
  - Giving inputs and observing output is also difficult
    - Signal variations are difficult to manage
- Do we understand analog circuits well? Can they help us develop the best computer in the future?

# Power of Digitization

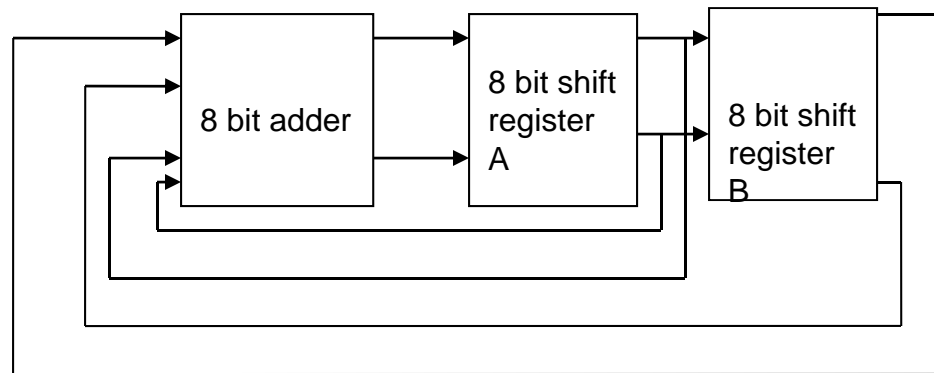
- All analog signals can be samples and converted to digital data signals using A/D converters
- Binary inputs are easy to manage and manipulate than analog values
  - Build a system based on digital processing of data
    - Use Flip flops and Shift Registers to store data

# Power of Binary Logic Circuits and Emergence of Software



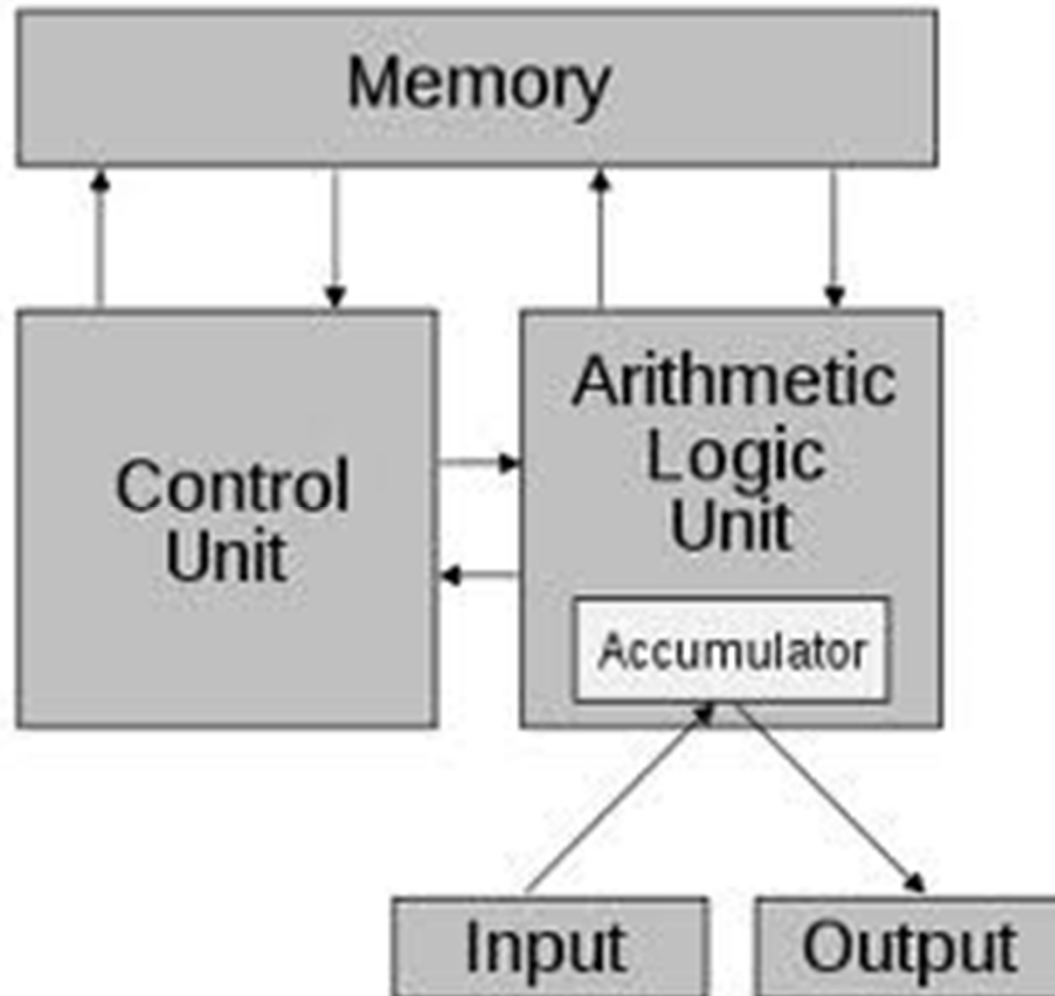
# Computer and Programming Idea

## Fibonacci number generator circuit



Initially two shift registers are loaded with 1.  
On giving a clock pulse the adder generates the next Fibonacci number and stores in register A. Earlier to that the contents of register 1 is transferred to register B.

# Von Newman Architecture



# Should we design and build Products?

We don't need a survey or too much analysis to conclude that India ranks very low among nations which enjoy and benefit from exploration, innovation, research, design and development of technology for the future.

Look at anything we want – airplanes, ships, guns, cars, buses, trucks, mobile phones, set top boxes, entertainment, processes, management theories - we have to get it from outside. We rarely have our own designs and ideas which are world class.

Many countries continuously find new ways to encourage, fund and support innovation for a better future on a continuous basis.



# Characteristics of Embedded Computing Applications

- **Complex Algorithms**
- **User Interface**
- **Real time constraints**
- **Multirate scenarios**
- **Manufacturing cost**
- **Power and Energy**

# Embedded System Design



Requirements

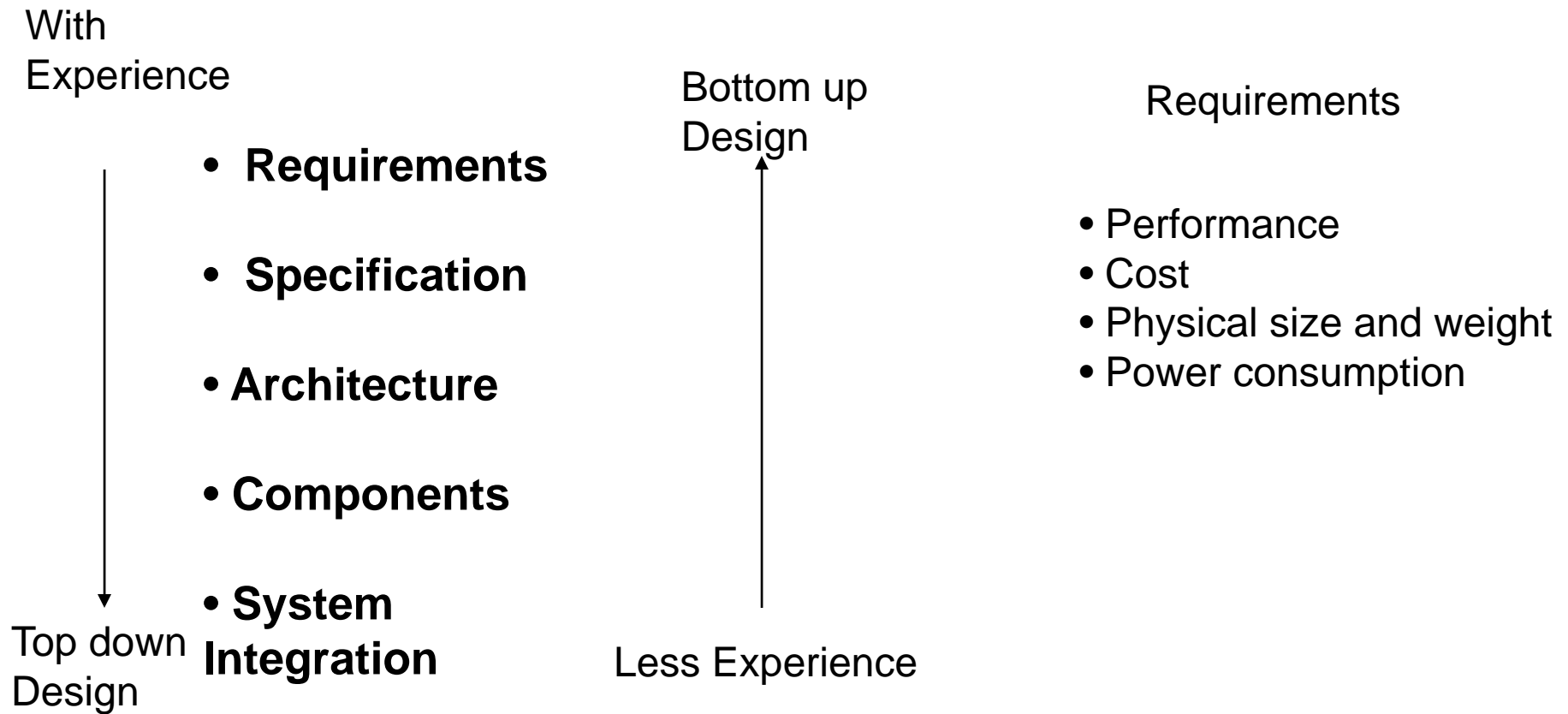
Specifications

Architecture

Component Selection

System Integration

# Embedded System Design Process



# A Design Problem : An Embedded System for controlling our behavior!

Design an embedded system by putting down requirements, specifications, a possible architecture and identifying required components for the following application. Specify important components of such a system. Discuss all the system components required to develop a complete product as much as possible using image sensors and other sensors if required. Do identify the algorithms which may need to be developed.

Application: A simple embedded system which watches what you eat from your plate and gives you feedback on balanced diet requirements and gives warnings if you tend to eat what may be not good for a preset number of health parameters prescribed by a doctor. Make suitable assumptions.