Prep for Texas Instruments

Who are we?

Texas Instruments Incorporated (TI) is a global semiconductor company that designs and manufactures semiconductors and various integrated circuits. TI is one of the top-10 semiconductor companies worldwide, based on sales volume and is focused on developing analog chips and embedded processors, which account for more than 80% of our revenue. TI has been a pioneer in many innovations in the semiconductor domain including the development of the first integrated circuit, the first patent on a single-chip microprocessor, the first single-chip linear predictive coding speech synthesizer, developing the prototype of the world's first transistor radio and the invention of the digital light processing device (also known as the DLP chip), which serves as the foundation for the award-winning DLP technology and DLP Cinema (used in IMAX theatres).

TI India was set up in 1985 and has R&D presence for all the major business units of TI including Analog (Data Converters, Amplifiers, Clocks & Synthesizers, Motor Drives, Power Management) and Embedded Processors (Connected Microcontrollers, Radar, ADAS - Advanced Driver Assistance, Infotainment Processors etc.) and caters to products for different market segments - Industrial, automotive, personal Electronics, Communication and Enterprise.

By employing the world's brightest minds, TI creates innovations that shape the future of technology. TI is helping about 100,000 customers transform the future, today. We're committed to building a better future – from the responsible manufacturing of our semiconductors, to caring for our employees, to giving back inside our communities and developing great minds. Put your talent to work with us – change the world, love your job!

To know more about TI, visit http://www.ti.com

Who are we looking for?

We are looking for individuals who are passionate about electronics, love to tackle challenging problems and build solutions that have an impact and can improve human lives though technology.

- **Basics, basics, basics!** Strong basics and fundamentals are what allow engineers to tackle new problems effectively
- **Perseverance** – people who quickly give up on a problem without trying or just saying "I don't know" without taking time to think, are pretty much immediately ruled out
- **Sharpness** – being able to identify patterns, and making logical leaps that can circumvent multiple steps
- **Thoroughness** – after making such a leap, being able to go back and justify the answer

How to prepare for the TI Selection Process?

Disclaimer: All the reference materials mentioned in this document have been collated based on suggestions/recommendations of individuals who have cleared the TI selection process. TI doesn't endorse these references. Users are advised to use their own discretion and judgement before utilizing these resources.

Digital:

1. Digital Electronics
    a. Combinational/Sequential Circuits
    b. K-Maps, Arithmetic Circuits
    c. FSM (Mealy-Moore)
    d. Flip-Flops
    e. Counters
    f. Pattern Detector Clock divider
    g. Synchronizers

    Reference material: Digital Design by Morris Mano
    NPTEL Lectures: https://nptel.ac.in/courses/117106086

2. Microprocessors/Microcontrollers
    a. RISC/CISC
    b. Pipelining
    c. 8085 architecture

    Reference material: Intel X86 Microprocessors by Barry Brey

3. Network Theory
    a. LC Circuits Steady State & Transients

    Reference material:
    a. Network Analysis – Van Valkenburg, Hayt and Kemmerly - Circuit theory
    b. https://www.edx.org/course/circuits-electronics-2-amplification-mitx-6-002-2x-0

4. CMOS Inverter Characteristics, Logic Gates

    Reference material:
    a. CMOS VLSI Design: A Circuits and Systems Perspective by David Harris and Neil Weste
    b. CMOS Digital Integrated Circuits by Sung-Mo Kang and Yusuf Leblebici

5. Design Flow, Static Timing Analysis (STA), Layout basics

Reference material:

a. Digital Integrated Circuits: A Design Perspective by Anantha P. Chandrakasan, Borivoje Nikolić, and Jan M. Rabaey
b. For STA: http://www.vlsi-expert.com/2011/04/static-timing-analysis-sta-basic-part3b.html

6. Verilog and VHDL

Reference material:

a. A VHDL Primer by J Bhasker; Verilog HDL by Samir Palnitkar
b. http://www.asic-world.com/verilog/

7. Signals & Systems

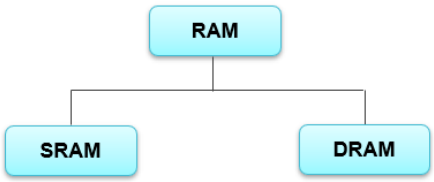
Reference material:

a. Signals and systems by Alan V. Oppenheim
b. https://www.edx.org/course/signals-systems-part-1-iitbombayx-ee210-1x-2
c. https://www.edx.org/course/signals-systems-part-2-iitbombayx-ee210-2x-2

8. Memory Types – RAM, ROM, EPROM, FLASH etc.
   a. Aspects of **digital computer organization**
   b. **Basics of C programming** - pseudo code testing for algorithm/logical thinking

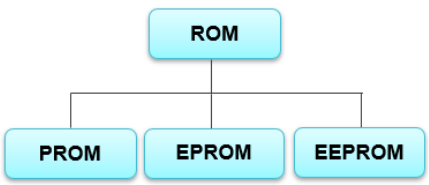
Memory Basics

- **Random Access Memory (RAM)** is a type of memory that is used to temporarily store data that the computer is currently using or processing.
  - RAM is volatile memory, which means that the data stored in it is lost when the power is turned off.
  - RAM is typically used to store the operating system, application programs, and data that the computer is currently using



» SRAM (Static Random Access Memory) retains data bits in its memory as long as power is being supplied → computer's cache memory (L2 or L3)
» DRAM (Dynamic Random Access Memory) must be continuously refreshed → Main Memory

- **Read Only Memory (ROM)** is a type of memory that is used to permanently store data that does not need to be modified
  - ROM is non-volatile memory, which means that the data stored in it is retained even when the power is turned off
  - ROM is typically used to store the computer's BIOS (basic input/output system), which contains the instructions for booting the computer, as well as firmware for other hardware devices



» PROM (Programmable read-only memory): It can be programmed by the user. Once programmed, the data and instructions in it cannot be changed.
» EPROM (Erasable Programmable read-only memory): It can be reprogrammed. To erase data from it, expose it to ultraviolet light. To reprogram it, erase all the previous data.
» EEPROM (Electrically erasable programmable read-only memory): The data can be erased by applying an electric field, with no need for ultraviolet light. We can erase only portions of the chip.

- **Flash Memory** is a type of memory that functions similarly to **RAM and ROM**.
  - **Flash memory** is an electronic non-volatile computer memory storage medium that can be electrically erased and reprogrammed.
  - The two main types of flash memory, **NOR flash** and **NAND flash**, are named for the NOR and NAND logic gates

Sample Questions: *(For all the sample questions, try solving them before looking at the solutions. Remember, the approach is more important than the answer!* 😊*)*

1. If a NAND Flash Memory has 16GB Storage Capacity & each memory cell can store 4KB how many memory cells are there in the chip?

   Solution: The total number of memory cells can be calculated as follows:

   16 GB = 16 * 1024 * 1024 * 1024 bytes

   = 16 * 1024 * 1024 * 1024 * 8 Bits

   Each memory cell stores 4 Kb = 4 * 1024 bits

   Number of memory cells = (16 * 1024 * 1024 * 1024 * 8 bits) / (4 *1024)

   Number of memory cells = 32,768 megabit (Mb)

2. Given a Memory with access time of 10ns and a clock frequency of 200Mhz, Calculate the number if clock cycles required to access the data?

   Solution: The number of clock cycles required can be calculated as follows:

   Memory access time = 10 ns = 10 * 10^-9 = 10/10^9= 1/10^8

   Clock frequency = 200 MHz = 200 million cycles/second

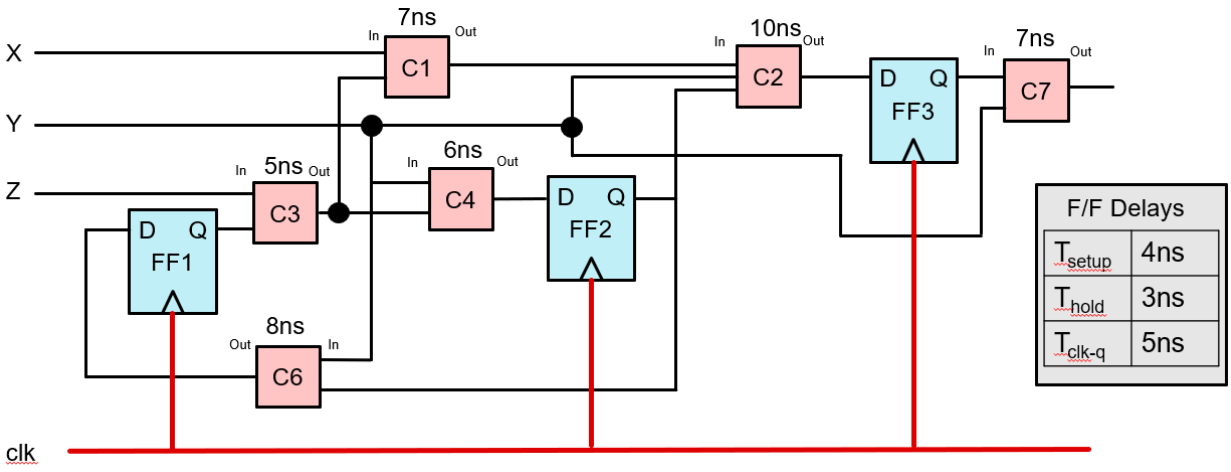
   Time Period = 1/200 * 10^6 sec = 1/(2 * 10^8) Sec

   Number of clock cycles required = Memory access time / Time Period

   Number of clock cycles required = 1/10^8 / (1/(2 * 10^8) =2

   Number of clock cycles required = 2

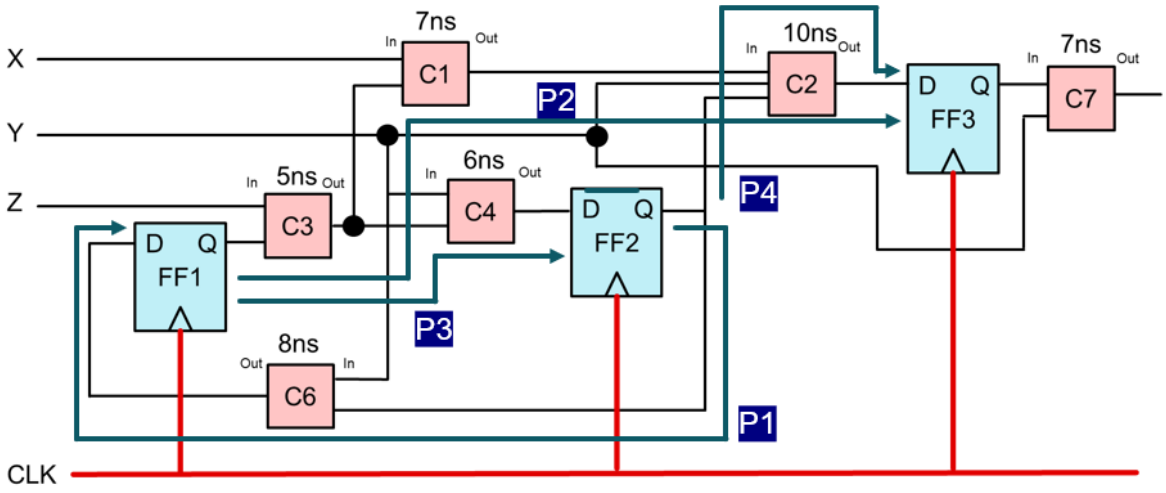
3. Find the critical path delay of the following circuit:



Solution:

- Identify all Reg-Reg Data paths
  - P1, P2, P3, P4

- Identify the longest delay path among P1, P2, P3, P4, P5 as the **critical path**
  - **P5 (C3->C1->C2) : Total Combinational Delay : 5 + 7 + 10 = 22ns**



Points to Ponder:

- What would be the maximum safe frequency of operation of the circuit?
  - Hint :
    - $T_{clk} > T_{clk\text{-}q}$(Launch F/F : FF1) + T_{comb_delay}(critical path) + T_{setup}(Capture F/F : FF/3)
    - Freq = $1/T_{clk}$
- Follow-up questions
  - What happens if there is a skew in clk signal in either direction?
  - What if clk frequency is more than the maximum frequency?
  - What would happen to this analysis if we have mix of positive edge triggered and negative edge triggered flops?
  - How to identify false paths?

4. How to implement a circuit that does 4-bit BCD Arithmetic?

Solution:

A. Let us discuss about how BCD addition is done
B. Valid BCD numbers are 0,1,2,3,4,5,6,7,8,9
C. Addition result should lie within this range, beyond should accordingly made to align within this with a carry of course
D. Generally, the addition of two 4-bit BCD values can result in one of the following conditions
   a) result equal to or less than 9

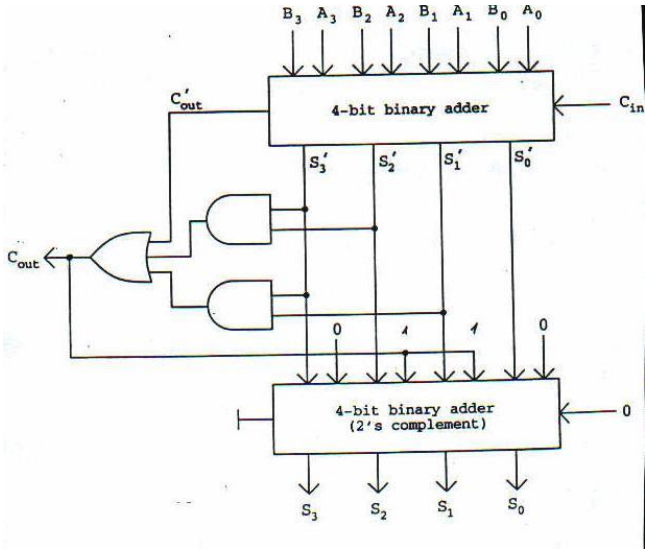
b) result is representable in 4-bit binary but greater than 9

c) result is with a carry

Under case (a) a simple addition is sufficient, while in (b) and (c) the result has to be brought back to the BCD form by adding value 6 in binary form.

E. In essence, the circuit would be a simple

- 4-bit binary adder
- logic to determine the cases for realignment to BCD
- And in those cases, conditionally add another "6" in binary form



Points to Ponder:

- Why are cases (b) and (c) treated differently?
- How adding value 6 in binary helps the cause
- How to do a BCD subtraction?
- What is the equivalent of a 2's complement binary addition, when it comes to BCD subtraction
- How to go about implementing a circuit for the same
- What if with additional select line used to decide addition or subtraction, one has to merge the two-logic circuit and make a design with minimal use of logic elements.

General Interview Tips & Guidelines

CV:

1. Clearly mention key achievements, projects, papers / publications, interest areas and grades in relevant courses

Personal Interview:

2. Think out loud while solving any question. The Interviewer judges you on the approach and not the answer
3. Pay attention to the question and think before proceeding, it is okay to take few seconds before answering if you are not sure
4. If you don't know the answer or are not sure about the answer, then mention the same before answering
5. There might be questions on areas that you have not worked on. That does not mean you completely give up and not answer. Try answering the questions based on the hints provided by the interviewer. The interviewer is trying to see if you would be able to solve a question logically even though you do not have a background on the topic
6. Show curiosity and your drive to solve problems. Ask questions, seek help and think aloud
7. If you have hit a roadblock, don't be afraid to go back to square one and start afresh on a new path