Job Hunting Guide for Analog/Mixed signal Circuit Design

by Fuding Ge

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Note !!!
Normally I do not reply emails from account such as yahoo, hotmail etc which I can not figure out where it came from.

To students majoring in Electric Engineering, Physics, Materials, Mechanics, Chemistry etc. Get a degree in Electric Engineering and find a good job in about one and a half year!!!

Remember: If you are not majoring in Electric Engineering, you can pursue a concurrent EE degree so that at the same time you can get financial aids. Your advisor should agree to let you do this. Ask the Graduate College about concurrent degree.

Some Experiences:

- For EE students, it is much easy to get a job in analog circuit design than digital circuit design. Generally speaking, there are more digital design job opportunities, but there are much much more digital students too !!.
- In the next three years, analog circuits design job opportunity should be great. Right now lot of company can not find applicants of analog circuits design engineer.
- Three useful Web Page of job finding: www.vjf.com , www.monster.com www.jobpath.com Build your own Resume and send it to the company directly use the web. Use key words such as "Analog IC design, Mixed signal" to search the jobs.
- I did not find that it is useful for campus Interview. But you should try it and get some interview experience. Yes, you need interview experience!
- You can send you resume to the same company many times, but not at the same time (for example sending it again one month later).
- Be consistant and persistant. Do not be frustrated if you can not get an offer for several months. When you get your first offer, you will find it is easy to get another offer. Interview experience is important. So I suggest you first interview some companies that you do not want accept the offer. When you can get offer from these unwanted companies then you know you have enough experience, skills, then try to interview company that you want to join.

- If you have Intern experience, it will be much easy to find a job.So try you best to find an intern if you can.

Courses:

You must take the following courses:

- Device physics
- Analog circuits analysis and design
- Advanced analog IC design
- A/D converter
- Digital circuits analysis
- VLSI design
- Filter design
- PLL design
- RF circuit design

You better to take the following courses if Available:

- Semiconductor and device characterization
- VLSI Architecture
- Computer architecture
- VHDL
- Logic Design

Some Basic Concepts you should know before job hounting:

You should grasp the following concepts:

- **Gain,** (how to improve gain?)
- **Bandwidth**, (how to improve bandwidth?)
- **Feedback**,(Stability is a must ask question! Know pole, zero, gain and phase margin!)
- **Slew rate,**(How to improve slew rate?)
- **Offset,**(how to eliminate offset? Chopper stabilized circuits, autozero)
- **Noise,**(what is thermal, flick, shot noise? What are the noises of BJT and MOSFET? (Tell me one way to reduce flick noise)
- **Compensation** (what is Miller, lead and Lag compensation? Know what is Miller Effects).
- **Layout** (centroid, interdigital) (how to improve the match of current mirror, differential pairs?,
- Remember: Same Structure (poly-poly not one is poly-poly another is poly-metal), same
- Temperature, same Shape and size, same orientation (current flow parallel), Same surroundings(dummy transistors) and Common-centroid geometry (fingers, interdigitated fingers, what is

the purpose of breaking into fingers?)) Suggested Reading: Koen Lampaert, Georges Gielen and Willy Sansen, Analog Layout Generation for Performance and Manufacturability,Kluwer Academic Publishers, 1999

- **Thermal resistance** (basic calculation).
- **Filter**
- **Oscillator**
- **Peak detector**
- **Frequency divider**
- **Bandgap Reference**

You also need to know a little bit about testing, for example DFT.

Some Good Books:

(Pay more attention on CMOS than BJT books)

- CMOS Circuit design, layout and simulation, R Jacob Baker, Harry W. Li and David E. Boyce, IEEE Press, 1998 (university of Idaho), TK7871.99. M44B351998. A good book to read. You may not be able to learn lot of theory, but you do learn some circuits you can use. It is a ENGINEER book.
- Analog Integrated Circuit Design, David Johns, Ken Martin, University of Toronto, John Wiley, Inc. A must read classic book on CMOS. Good circuit cook book and circuit theory. The part of Switched-capacitor PLL parts are very good and you must know it.
- Microelectronic Circuits (the latest edition is 4^{th}). Adel S. Sedra, Kenneth C. Smith, Oxford, 1998 (University of Toronto). A very good book! It is for undergraduates, easy to understand and the summery is very good and equation is very insightful. A must-read book before interview.
- CMOS Analog Circuit Design, Phillip E. Allen and Douglas R. Holberg, Published in 1987. A little older but still worth to read. (It has a later edition (2002 ?, but I have not found time to read yet).
- Design of analog CMOS Integrated Circuits, Behzad Razavi, McGraw-Hill, 2001. A textbook used by many schools. It helps you understanding lot of the circuits, but too simple to use in real design. I should say it is a very good theory book. Not ENGINEER book. Anyway IT ALL BEGINS FROM MAXWELL'S EQUATIONS, RIGHT?
- Principles of CMOS VLSI Design, A System Perspective, Neil H.E. Weste, Kamran Eshraghian, AT&T, 1993
- Fundamental of Logic Design, (Any textbook is OK)

Basic Questions (usually asked in phone interview)

1. Tell me a little bit about semiconductors (what is conductance and valence band? Fermi level? For n type semiconductor, what is the doping? Do you know how to say P and As in English?)

2. How does a pn junction works? (I know you know it, but could you tell other people clearly? Try it!!!, They ask you this question!). What is the depletion region? What is the build-in potential? What is the relation between these parameters with doping concentration and temperature? Remember the tempo of the build-in potential is about ?mV/K.
3. Tell me how MOSFET works. (Write it down in your own words and remember it !!!).
4. Tell me how BJT works. (Should I write down and remember it? Sure! But it is less asked). How does Vbe and Ic change with temperature?
5. Threshold voltage: If the substrate doping concentration increase, or temperature increases, how will Vt change? it increase or decrease?
6. Tell me what is Channel length modulation, what is Early effects and their physical origin.
7. Tell me what is short Channel effect.
8. For a 0.18um and 0.8um technology MOSFET, which has a higher cutoff frequency?
9. How does a Bandgap Voltage reference work?
10. What is the ideal input and output resistance of a current source? How about voltage source? How to improve these parameters? (Cascode topology, use long channel transistors)
11. Tell me the parameters as many as possible you know that used to character an amplifier.
12. What are the two types of noise of MOSFET, how to eliminate them?(Thermal and Flicker).

ABOUT DIGITAL CIRCUITS/VLSI DESIGN:

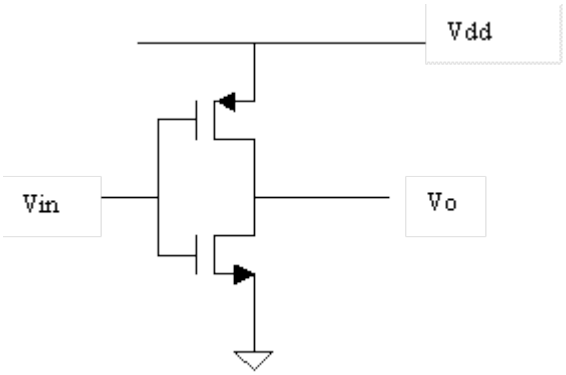
Though you are applying for an analog circuits position, they often also ask you one or two digital/VLSI questions. To my experience, some basic logic gates such as NAND, NOR, XOR (XNOR) circuits are very important. Sometimes they ask you to use NAND NOR gates to realize the XOR function, some times they even ask you to use 8 transistor to realize this function. To my experience, you should read the whole textbook by Thomas A. DeMassa "Digital Integrated Circuits" including those parts that talk about Flip-Flop. They often ask you a small question about State Machine or State Diagram. If you do not has the basic concepts of these concepts, read some books or take a course. When I interviewed with Intel, they asked me to use some logic gates to realize a traffic light control problem (which I was unable to do in the specific time).
If they want to test your layout concepts, they may ask you to draw the layout of NAND/NOR gate. Read the book "Principles of CMOS VLSI Design, A System Perspective, Neil H.E. Weste, Kamran Eshraghian, AT&T, 1993" to get some "feeling". At this point they may also ask you questions about ESD/Latchup, the above book is also good to refresh your memory.
Set-up and hold time are also very important concepts. You should know them for sure.

Some On-site Interview Questions

Almost everyone of the following questions was asked to me by an interviewer. Special thanks to Ge Wang at Maxim, Zhitao Jiang at Motorola.

(About 30 questions will be added perhaps three months later. If you are interested in them and find I do not add the questions at that time, send me an email to remind me. **Note:** I will **NOT** add any questions at this section, Feb 6, 2004. Normally I will **NOT** reply emails from yahoo, hotmail account, please use your edu account or other work related account if you like me to reply.)

1.If the following inverter biased in the middle of Vdd, what is the small signal gain? (Answer gmXro)



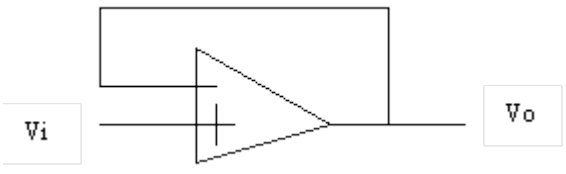
2. Crossection diagram of the inverter (be able to draw the contact of power supply and ground)

3. From the crossection of the diagram, be able to draw the parasitic BJT leads to latch-up.

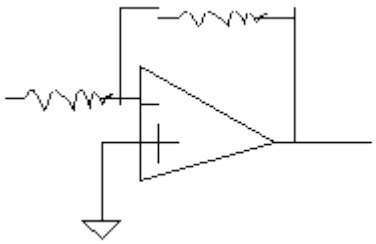
4 . How to prevent latch-up (do not forget guard ring, clampping circuits!)

5. Draw the layout of an inverter or NOR/NAND gate.

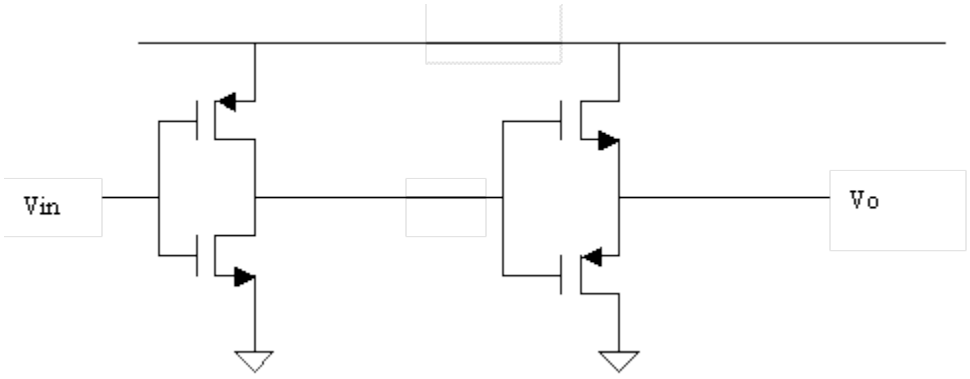
6. For the following source follower, what is its -3dB bandwidth? How about it stability?



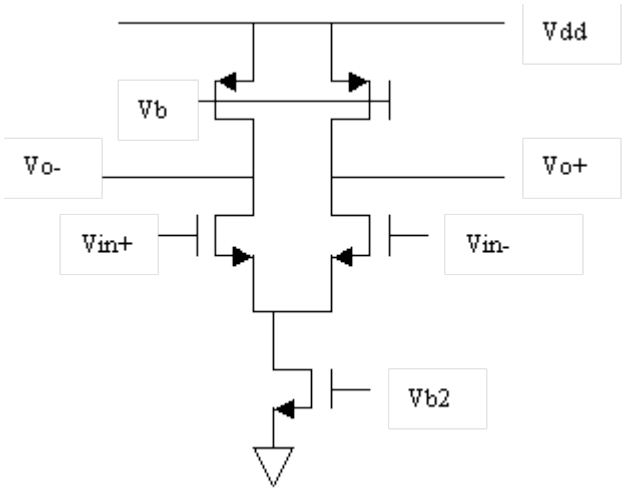
7. In the following figure, if the two resisters are equal, what is its -3dB bandwidth? Compare its stability with that of a source follower.



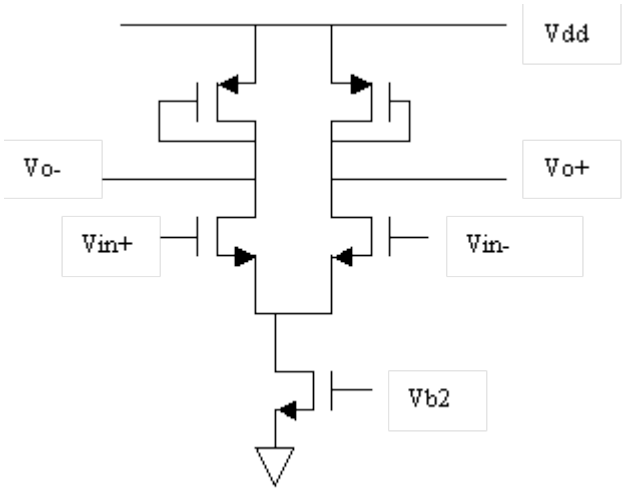
8.For the following circuit, if the input is a rail-to-rail square wave, plot the wave after the inverter and vo.



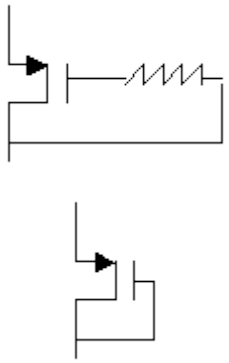
9.For the following circuits, What is the gain? Using what technology to improve the matching of the input transistors? If the bias current increase, what happens to the gain? (Hit: Decrease!!!) What happens to the bandwidth? Replace the NMOS with npn BJT and PMOS with pnp BJT, answer the above questions.(Now gain remains constant with increasing biasing current!)



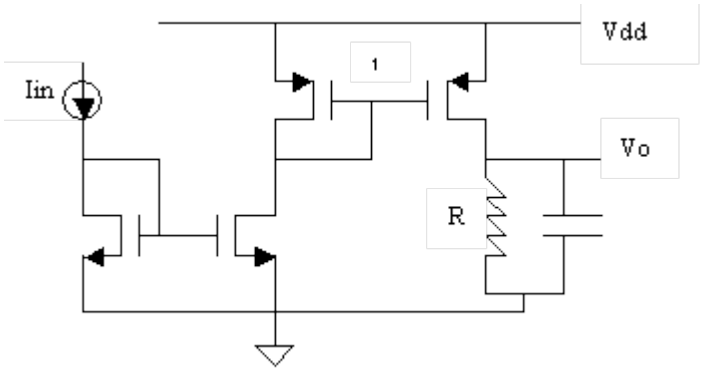
10. For the following circuits, answer the questions again. What are the advantages and disadvantages of these two amplifiers?



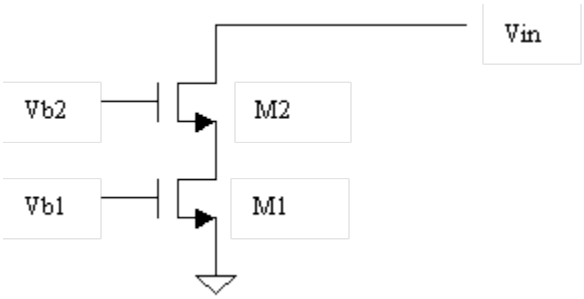
11. What are the effective resistance from source to drain of the following two transistors? (The value of the resistance is R). Answer: both of them are 1/gm.



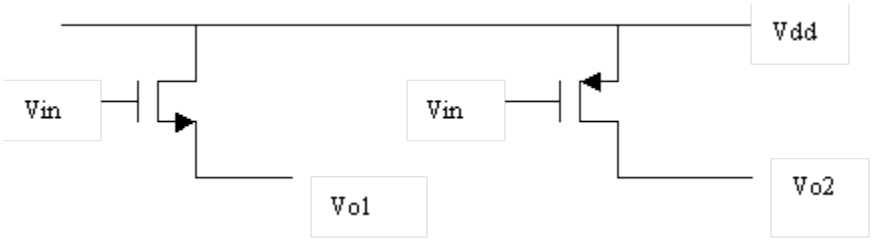
12.What is the low frequency gain of the following circuits? The input is the input current Iin. Where does the dominant pole locate? How about the pole at node 1?



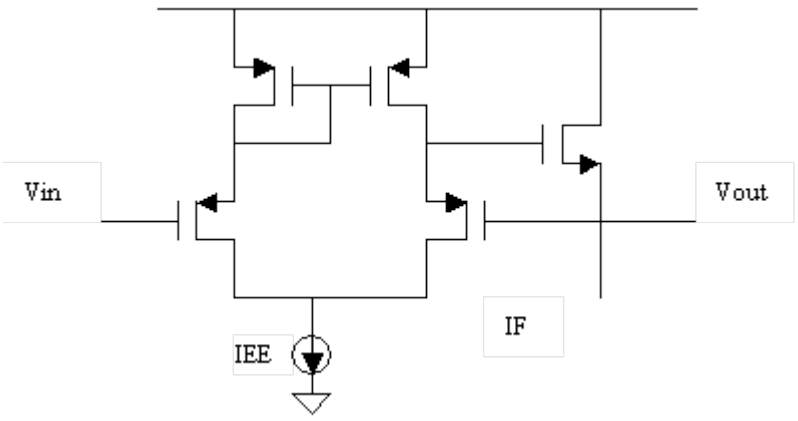
13.For the following circuit, the threshold voltage of the transistor is 0.7V. Vb1=1v, Vb2=2v, When Vin change from 5V to 0V, draw the current flow through the transistors VS Vin. (This question was supplied by Wang Ge)



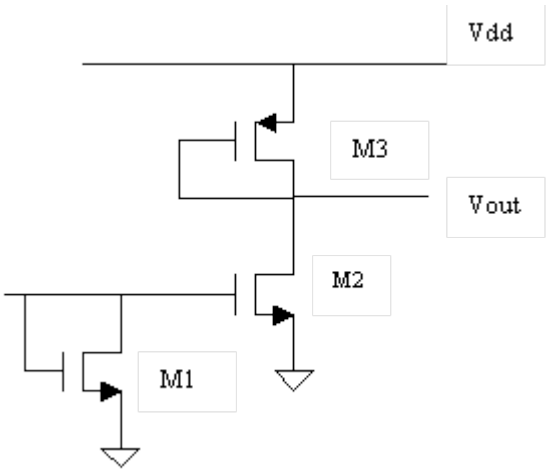
14. For the following circuits, Vdd=5v, tell me what are Vo1 and Vo2 when Vin is 5V, 3V, 2.5V and 0V.



15. For the following circuit, what is the gain of Vout/Vin? Where is the Feedback and what is the function of feedback?



16. For the following circuits, the small signal input is i_{in}, the small signal output is v_{out}, what is the small signaloutput? What is the gain?



Newly updated questions

at March 2004
As I said above, I would put more questions when I first set up this page...then I always feel to busy to do it...and I got a lot of emails asking about this...this made me feel guilty, a little. And FINALLY a few more questions come out. These question are maily on RC network. they are simple, but really are often asked. I was asked almost every question one way or the other.

17. Figure out the Vout wave form of the following circuits:

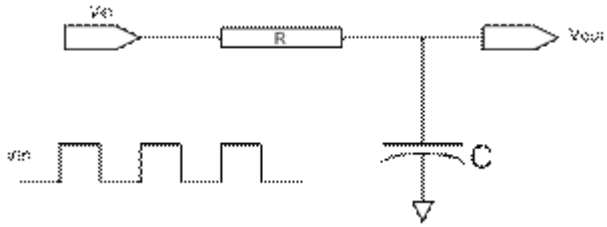


Figure 1

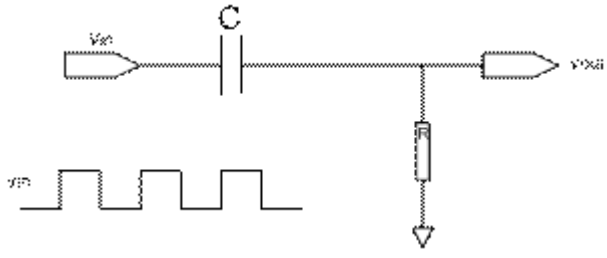


Figure 2

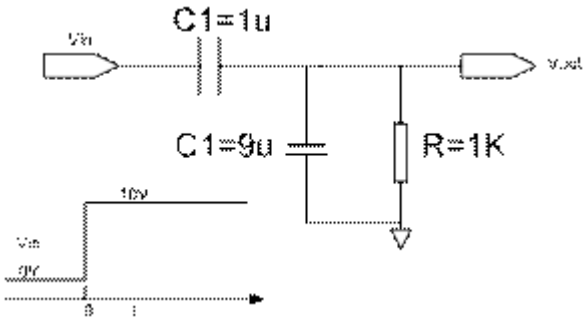


Figure 3

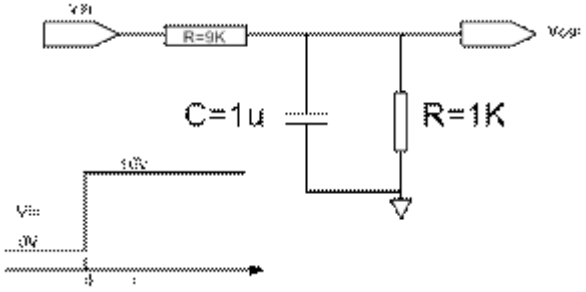
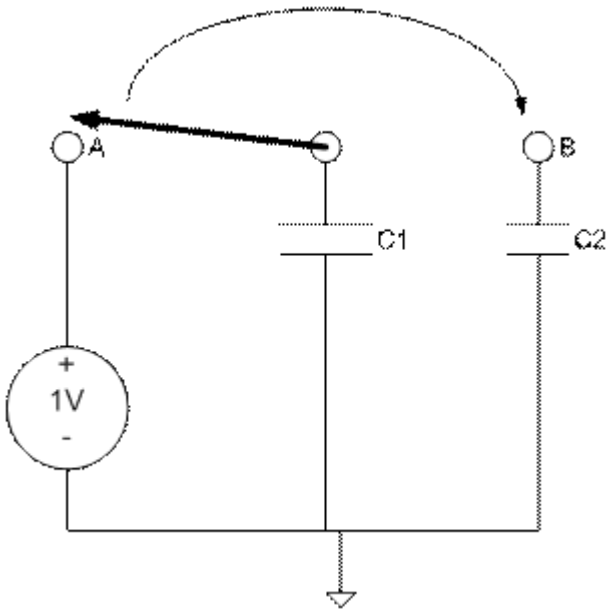


Figure 4

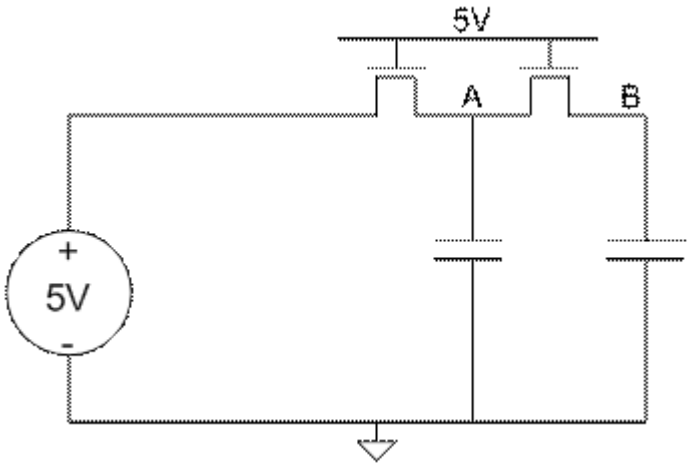
Answer Hints: The basic concept to reply these kind of RC (or RLC) network questions is that: for C, it resistance is infinity when frequency=0 and 0 when frequency is infinity. (For L, its resistnace is 0 when frequency=0 while its resitance is infinity when frequency is infinity.

18. For the following circuit, at time 0, the switch switches from A to B, figure out the voltage wave form at B.

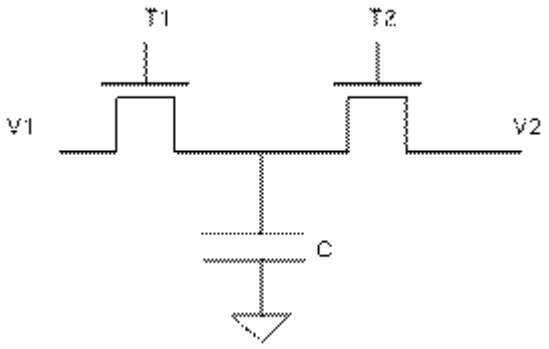


Note: this is a "classic" question. It was asked 10 years ago and I was asked this question just recently. You might be asked this question next time...

19. Fo the following circuit, what is the voltage value at A and B? (The Vt of the transistor is 1V).



20. The capacitor of the following figure is connected with two ideal MOS switches. Switches T1 and T2 are alternately turned on with a frequency ff_c. What is the average current flowing from node 1 to node 2? What is the equivalent impedance from node 1 to node 2?



21. You are porbing a square wave pulse in the lab that has a ris etime of 5 ns and fall time of 2 ns. What is the minimum bandwidth of the oscilloscope to view the signal?

Answer: The time thay it takes an RC circuit to go from 10% to 90% of its final value is t=ln9*RC. The bandwidth of the oscilloscope larger than BW=ln9/(2*pi*2ns)=174MHz. Choose a 200MHz or faster oscilloscope. To reduce error, choose a oscolloscope 3 time faster than the calculated value, or 600MHz.

22. A interesting question (question provided by Manjul Mishra). .

Note: Problem 20 and 21 are copied from the book edited by Jim Williams *"The Art and Science of Analog Circuit Design*", published by Butterworth-Heinemann, 1995. ISBN 0-7506-9505-6, the chapter by Robert Reay, "A new graduate's guide to the analog interview". The chapter has 20 interview questions, but most of them are BJT problems. It may be helpful and interesting to read the chapter and even the wholw book. It is an INTERESTING book, though may be not very useful. It even includes a chapter by Richard P. Feynman (who is that guy? Come on, you should know him!).

Now my own story about this book. Just before I got my master degree in Electrical Engineering, I was looking for a job as an analog circuit designer. After some struggling, I finally got an onsite interview. Just before the day of the interview I went to the campus book store - I often go to the book store to look around - and found this book by chance, and fortunately found that chapter about interview. I read the chapter and found I could not answer many of the problems. I made some notes at the book store, and burn some night oil to understand the answers, because at that time this was the only book I could find that talked about interview. You know what? when I went to the interview the hire manager just gave me a problem sheet and show me a room then let me to write down the answers...and most of the problems are from this book !!! ...of course they were impressed by my so good and so quick answers !!! (But they did not gave me the offer at last, it was another story, though. Even after two years of the interview, they still remembered me, and my so good answers ^_^. Obvious not so many students had read this book before me, and even after me, I guess. They interviewed a lot of candiadtes before and after me).

Return to Job Hunting Guide Page

What to learn more on circuit design, go to my circuit web page Fuding's Circuits

Do you have any interview questions, experiences you want to share? You can send to me, I then put it here.

Updated at Jan, 2005:

I received some comments, interview questions from readers. Thanks those who wrote to me. I replied some eamils, and some I did not reply. Normally I do not reply emails from account such as yahoo, hotmail etc which I do not know where it came from.

Recently I received a email from a technique recruiter, who gave some suggestions, which I think are quite interesting. I put here for your reference. His webpage is www.veriseo.com .