

## Experiences in an interview at CMI

by Manjil Saikia - Tuesday, December 25, 2012

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I was standing outside the door of room no. 5. My heart bit was running like mail express. I was trying make myself cool and comfortable but I was unable to do so. I knew it no matter how much struggle I do to make myself easier for the interview, whenever I would enter the interview room, definitely I would get nervous. May be that is why I was sweating.

It's been a long time I was waiting for this day. While I was in my B.Sc, I appeared in CMI entrance exam to get admission in M.Sc. in mathematics. CMI, one of the prestigious institutions all over the India which every math student dreams about to persue the higher study. Although I cracked all most all entrance exams in Mathematics for getting admitted in M.Sc. but I couldn't get success to pass CMI's entrance exam. But luckily that time was the second appearance and I did well. I knew it I will be called for final merit list and bingo!! After the final list was published, I found my name at the top of the list. Unfortunately I was unable to join CMI that year. But I made it again this year. I can remember I was attending National level training program in Differential Equation in IIT Delhi during middle of June and my friends asked me "How will you appear the exam? You are completely detached from the study materials." I was smiling because I knew my confidence level. I knew that the moment I would get the question paper, I would be able to write the right answer because my concept was clear. After appearing and getting selected all most all entrance exams of prestigious institutes, if I can't crack CMI, then what had I learnt? And it happened. I can remember the invigilator was laughing at me during the exam hour of CMI written test. She asked me after the exam, "you did well, isn't it?" I replied "yes ma'am. How did you realize?" "She smiled, "the way you were sitting it seemed like you have written all the answers. Am I right?" "I told, "ya, but not all. I covered 90 out of 100". "-How much time did you take?" I told, "merely 45 minutes."

"Anjan. Hey you there!!" one interviewer was standing few steps ahead of me and was calling me. I returned to the 'CMI- reality' from my memory recalling. "yes sir? " " Please wait few minutes. We'll call you soon". I nodded my head. Heartbeat got faster again.

Today was a shiny day. CMI viz Chennai Mathematical Institute campus was very beautiful. Entire campus was full of white building. And they were glowing after the reflection of sun. I came here through the CMI shuttle which departed from IMSC, another A grade level research institute in mathematics in Chennai. In the shuttle, I was seated. "Interview today huh?" question came from my behind. I looked at the person and answered, "yes sir". "Hmm. What's your name ?" "Anjan. Anjan Debnath, sir." "All the best for today" he smiled. I don't know but a strong feeling attacked my mind , most probably he would be in the interview panel. And I was right. After reaching CMI and getting down from the bus, he told me, " Please go and wait in the class room 5. We shall call you ". I don't know but immediately got nervous by knowing that after few minutes, I have to enter 'the operation theater'.

12.05 pm.

“-Anjan”

“-Yes sir?”

“-Everyone is waiting for you. Please come”.

I kept my college bag in the classroom. Then I marched towards the Interview room.

It was a big hall after all. Actually it was a class room. I saw at least 7 professors were sitting there. Each was sitting individually in a different style and each was occupying one desk. It seemed like their attitude was telling me “come boy. Let us start your biopsy”. I was standing in the middle of the class for I think at least 1 minute. The person whom I met in the shuttle was also there. He asked me “Please be seated”. I took my sit but I was staring them. He again smiled, “don’t panic Anjan. Everything will be fine. We won’t eat you now. Just after few moments” All interviewer started laughing. I became confuse if I should join them or not.

Then it began.

“-So Anjan, in your application you have written that you have done something on Number theory.”

“-Yes sir”.

“-You mean research work right?”

“-Umm...ya you can say that sir.”

“-Ok. Will you please tell us something about it?”

“-Sure sir.” I moved to the board, took the chalk and started, “the paper is on Beal’s Conjecture which is the generalization of Fermat’s Last theorem”. They were looking at each other. I knew it why. If a student says he had done something on Fermat’s Last Theorem, well, at least math people will look at him in total disbelief. I continued, “ Now FLT, means Fermat’s Last theorem says that if  $n$  be any natural number greater than 2 then the equation  $x^n + y^n = z^n$  will have no integral solution. Beal’s conjecture is almost same as it. It says that if  $x, y, z$  are co prime then  $x^a + y^b = z^c$  will have no integral solution provided  $a, b, c$  are natural number greater than 2.”

“-Ok. So how did you proceed?”

“-Coming to that point sir. First of all, I considered a more general form of this equation and let.....”

I won’t make the reader bore after describing this part. Also it is related to my research area so I need to skip it.

“-Hmm. Impressive. Have you shown your paper to any one yet? “ I nodded my head left to right and

right to left. “Well you should do that”, one of the interviewer advised, “anyway, shall we ask you something from your course?” “Sure sir”, I replied.

“which topic would you prefer ?“

“aamm, number theory sir”.

“Ok. What have you studied in Number theory?”

“GCD, Congruence theory, Binomial theorem, primitive roots, Quadratic reciprocity law....”

“What is primitive root?”

“Suppose  $n$  is any natural number”, I started writing on the board,” and consider the set  $U(n)=\{ r \text{ is natural number such that } (r,n)=1 \text{ i.e. } r \text{ and } n \text{ are relatively prime} \}$ . Then-“

“ Suppose that  $n$  is 8. Then ?”, one of the interviewer interrupted me. I told, “ well then the set will be simply  $\{1,3,5,7\}$ .” He asked, “and then? Why did you stopped? See,  $r$  is not bounded.”

I looked at my write up. Opps!! I made my first mistake. “Sorry sorry , sir it will be  $\{1 \leq r \leq n\}$ ..” I told.

“Oohhk” he chuckled. “Please continue”.

“Now under the multiplication this set will be a group....” Again I was interrupted,” Is it multiplication or something else?” they asked. I stopped again, thought again and then replied that multiplication modulo  $n$  would be there. “ But you didn’t mention it!” I told myself so what? I am telling now. But being polite I answered him, “sorry sir, my mistake”.

I understood my biopsy had been started already.

“Ok, leave it Anjan. Suppose that as you said,  $U(n)$  is a group. Will it be abelian?” “Of course sir”, I told. “Why?” they asked. “Because the binary operation is multiplication modulo  $n$  and that is commutative”. They seemed to be little cooled down but then again they started, “ so will it be cyclic?”

“No sir,  $U(n)$  is not in general cyclic but if  $n$  is of the form  $2, 4, p^n$  and  $2p^n$ ....”

“what is  $p$  here?”

“ $p$  is odd prime. If  $n$  is any one of this form then only  $U(n)$  will be cyclic.”

One of them fired the bullet,” Can you prove the case of  $2p^n$ ?”

I was stunned. At that moment it was not coming to my head. I told him, “sorry sir, I don’t know”.

He stared at me and after few moments he told, “No problem. So if  $U(2p^n)$  is cyclic then can you

write the structure of it?" Well that was easy. I knew the relation between  $U(n)$  and  $Z/nZ$  group. I started writing the isomorphic relations one by one. But then I got stuck and started thinking.

I was very tensed this time. After few minutes, one of the interviewer asked me, "what about  $U(p^n)$ " which I till then didn't write. Suddenly it hit my brain and I completed the list. He asked, "is this your list or you want to contribute more?" I replied, "no sir, that's all."

They point out one of the relation between them which was  $U(p^n) = Z/(p^{n-1})Z$ . I was asked, "what is the order of  $U(p^n)$ ?" I replied, "its  $p^{n-1}$ ."

"-Can you prove that?"

"-Let us consider the set  $A = \{1, 2, 3, \dots, p^n\}$ . Then as we can see that the numbers prime to  $p$  are nothing but  $p, 2p, 3p, \dots, p^{n-1}$  viz.  $p^{n-1}$  so...."

"-Ok that's enough! We understood you can do it. Let's move on to next question." I relaxed myself again. Thank god!

Meanwhile another professor entered the room. He became my next interviewer, "Ok, now I am giving you a number theory problem. Solve it". I nodded my head in agreement.

"-Prove that the binomial coefficient  $\binom{n}{r}$  is integer for all."

Some times in life just a little problem can be a great disaster. That day this was that type of question. Countless number of times I had used this but when I was asked to prove it, I don't know what had happened to me. My brain got blank. I started mumbling. I tried. I wrote the combination formula, then told them, "as we know product of  $r$  consecutive integers is divisible by  $r!$  so it will be integer. Hence we are done."

"-Ok then prove that product of  $r$  consecutive integers is divisible by  $r$  factorial."

Uff! I was feeling myself as 'Abhimanyu', surrounded by 'the saptarathee'. One person attacked this side then other person from other side. I was totally drooled, "sorry sir".

"-well it's easy. You can use induction."

I didn't understand where I should use induction as there were  $n$  as well as  $r$ . I did some calculation but then the professor answered, "its very easy. Suppose it is true for all  $n$  and all  $r$  such that  $0 \leq r \leq n$  right? Then use the triangle rule  $\binom{n}{r} + \binom{n}{r-1} = \binom{n+1}{r}$ . It will be done."

I did exactly what he said. Then I smiled in shame, "yes, you are right."

"-easy isn't it? Did you know this before?"

I agreed to him.

“-All right. Shall we ask you from any other topic? You see, if you are going to do PhD, then you have to know the subject material very clearly. Which book did you followed for Number theory?”

“-Nivan Zuckerman....”

“-But that book is not enough. It is full of theory. Better you should focus on theory part also. What are the other subject area did you study in M.Sc?”

I replied, “ Algebra, Real analysis, Complex analysis, ODE PDE ...”

“-Which book did you follow for abstract?”

“-Sir, personally I studied Gallian (the interviewer nodded his head with appreatiation) for problem solving and for theory, our course instructor provided the notes. She used to make her notes from couple of books.”

“-What are they?”

“-Artin, Herstein, Dummit and Foote and some others.”

“-Shall we ask you from analysis?”

“-Real?”

“-Ok, as you wish. Suppose that  $X, Y, Z$  be there metric space.....”

Another interviewer interrupted him, “wait wait. Let us start from basic place. Anjan, suppose that  $f$  is a real valued function such that its second derivative is discontinuous. Can you give some example?”

The former interviewer seemed little disappointed, “listen Anjan, what ever you want to write, make it correct and complete. You are a math student so you can't cancel or change what you write here. You may take your time, think it or?”

“-Yes sir. Please give me some time then I can solve this problem”.

“-Hmm. Take your time.”

I started scribbling on the board. Seeing that I was far away from the answer, the professor asked, “hint?”

I looked at him. He told, “you see particularization will not be helpful. Let's think on general. Suppose that you are given a function of  $C^n$  class. How can you get a  $C^{n-1}$  class function?”

How come on earth that could be a hint to my problem I couldn't understand. I was silent.

“-What operation helps us to get a 4<sup>th</sup> degree polynomial from a given 5 th degree polynomial?”

“-Its differentiation, sir.”

“-What operation helps us to get 5<sup>th</sup> degree polynomial from a given 4<sup>th</sup> degree polynomial?”

“-Integration”, smile came back to my face. I caught the clue.

After that it was easy. I make the polynomial function with component wise part discontinuous at exactly one point. Then integrate it. While I was adjusting the constants, they concluded the interview, “thank you Anjan. That’s enough”.

I stopped. Took out the handkerchief, remove the sweat from my forehead. “How do you feel now?” they asked . They were smiling. I replied, “nothing special sir.”

“-Have a good day then.”

After then, there was nothing to do. I came out from the room and watched my watch , it was 1.10 pm. So at least one hour I have spent in the ‘operation room’.

Phew! That was a day of my life.

**[The author, Anjan Debnath is a MPhil student at the Ramanujan Institute for Advanced Study in Mathematics, Chennai.]**

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