Introduction to Research
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Lecture – 46
Research in Mathematics

Prof. Prathap Haridoss: Hello. We are a pleased to have with us Prof. Arindama Singh from the Department of Mathematics and he will discuss with us you know, research in mathematics and aspects of research associated with you know student life and how it interacts with you know their research at in their department and so on.

Prof. Arindama Singh has a PhD in mathematics from IIT, Kanpur and he has been here at IIT, Madras, as a faculty for more than two decades now, since 1995 and has a lot of you know a rich experience in working with students in actually various capacities because he has also held several positions in the institute which deal with you know critical aspects of a student life here.

And incidentally you should also look him up on the internet. He is a very interesting personality, I had the opportunity of looking up lot of information on a about him. So, if you get a chance please do look him up he has a written a lot of things about his experiences in life in generally in addition to his provisional activities. So, thank you for joining us.

So, I would like to start by looking at this aspect that you know at least in engineering background. We tend to have you know in any engineering division, we have areas of activity which are considered traditional areas of research. In mathematics, is there such a thing, is there such a concept like you know these are the traditional areas of research which are there and then, and which have been there for a long enough time, but there is still research going on it and therefore, there is a lot of literature that people can look at and you know engage themselves against.

Prof. Arindama Singh: Yes, as usual mathematics is in fact, living traditionally so obviously, the old areas never die.

Prof. Prathap Haridoss: OK.

Prof. Arindama Singh: But new areas being added due to applications and some other programs coming up in daily life. So, like we have the geometry we started from Euclid or so, it is still living.

Prof. Prathap Haridoss: OK.

Prof. Arindama Singh: Research is going on in geometry in various aspects of it. Similarly we have analysis which is very traditional, algebra. So, these are some of the branches. In fact, these comprise the whole of mathematics. Any branch of mathematicians you take it is somewhere related to one of this.

Prof. Prathap Haridoss: One of this.

Prof. Arindama Singh: Or even all of this.

Prof. Prathap Haridoss: OK.

Prof. Arindama Singh: So, they are still living have, however in India sometime back fluid dynamics too care of almost everything.

Prof. Arindama Singh: Any department you go there will be some people working in fluid dynamics.

Prof. Prathap Haridoss: Fluid dynamics.

Prof. Arindama Singh: That is an engineering subject. So, slowly it is dying from mathematics departments.

Prof. Prathap Haridoss: OK ok.

Prof. Arindama Singh: And some pure math, that is being established everywhere.

Prof. Prathap Haridoss: OK.

Prof. Arindama Singh: So, that is the trend now.

Prof. Prathap Haridoss: So, new areas of research of would be.

Prof. Arindama Singh: Yes.

Prof. Prathap Haridoss: I mean in what would be cover? What would constitute like you know areas which have sort of come upon you very recently that well, it may be say let's say the 5-10 years time frame that many may be in their many groups interested in looking at.

Prof. Arindama Singh: So, after this advent of computers, new areas like numerical series.

Prof. Prathap Haridoss: OK.

Prof. Arindama Singh: Then computer science related mathematics. For example, discrete mathematics, data structures, theory of computation, then image processing and anything related to numerical like - numerical linear algebra, for example. So, these areas have come up recently.

Prof. Prathap Haridoss: So, you yourself in fact, expert in Numerical Analysis.

Prof. Arindama Singh: Yes, I am also related to one of those.

Prof. Prathap Haridoss: Yeah, Computer Science, Theoretical computer science kind of activities. Okay so, these are the newer areas that in mathematics the people work on actually. Okay In the sense in fact, if we look at may be students coming into mathematics department what sort of backgrounds do they come in I mean are they only are they almost uniformly you know bachelor or B. Sc in a mathematics kind of background or you see different, do you see enough engineering students moving to mathematics in the PG programs.

Prof. Arindama Singh: Not many engineers coming to mathematics, but there are one or two.

Prof. Prathap Haridoss: OK.

Prof. Arindama Singh: In every one or two years, we get one or two engineering students who is so interest in coming to mathematics and they also do good research after that we find, but uniformly it is M. Sc from mathematics.

Prof. Prathap Haridoss: OK.

Prof. Arindama Singh: That is our intake

Prof. Prathap Haridoss: OK.

Prof. Arindama Singh: So, in some of the places where mathematics and statistics both are there. So, M. Sc statistics people also come.

Prof. Prathap Haridoss: OK.

Prof. Arindama Singh: For doing research.

Prof. Prathap Haridoss: OK ok. So, in terms of the students coming in they probably come with an wide range of different institutions from which they have been educated

for their B. Sc and M. Sc and may be as you said you know one or two engineering students and what not. When they come in, in terms of settling into doing a research kind of a program here in mathematics department here, are there a specific issue that you students facing as they settle in it may be the early part of their graduate or post graduate life here in terms of technically adjusting to what is required here and so on.

Prof. Arindama Singh: Yeah. There is in fact, our interns should be able to take care of this issues.

Prof. Prathap Haridoss: OK.

Prof. Arindama Singh: But it does not because of various reasons. We have to load or narrow down this scope, so that it should be accessible to many people. So, in that sense we keep our interns in such way that it is come on to all almost all the universities in India, which are doing in the B. Sc programs. So, that do we get students from almost all the places and then we have the problem of bringing that standard of, so that they will be almost equal in 1 or 2 years and that's a gigantic task, in one year it's not possible we know, but then we have to give some courses which will be very basic to them. So, that is the idea.

Prof. Prathap Haridoss: OK.

Prof. Arindama Singh: And then during this course work of period they take the courses which are useful for the research also not only on the general mathematics, but also narrowing down to their research area. So, at least 1 or 2 courses are given from the research area so that they will be going faster.

Prof. Prathap Haridoss: OK.

Prof. Arindama Singh: This idea of course work is really very important for the research students. So that they will be equalized to you over 1 or 2 years and then they will also be earning some expertise in their narrow down area.

Prof. Prathap Haridoss: In terms of any other preparation in terms you know. So, basically you are saying may be the rigger is what they have to pick up on.

Prof. Arindama Singh: Yes.

Prof. Prathap Haridoss: When they come in and it takes some may be a year or two to settle into this regard rigger, of course, when we think of I know basic sciences you know including physics, chemistry, mathematics and so on, especially with respect to mathematics, The I mean atleast the perception is that you know may be the industry general industry that is out there, which has a lot of people to what degree does that industry I mean see show interest in graduates of a mathematics or in what you know aspects of industry is there you know nice fit between people who are doing an advance degree in mathematics an MS or PhD degree and the what the industry might desire or even say some section of the corporate world may decide.

Prof. Arindama Singh: Yeah. So, in the traditionally people are thinking that industry might take who are doing well in fluid dynamics. But that is not happening in India.

Prof. Prathap Haridoss: OK.

Prof. Arindama Singh: So, there are many industries who use these concepts and foods products are even their process can be optimized by using these methods, but they don't ask for it. And when we go for them they are also reluctant.

Prof. Prathap Haridoss: OK Ok.

Prof. Arindama Singh: Because there is a fear of losing their jobs, or some such.

Prof. Prathap Haridoss: OK Ok.

Prof. Arindama Singh: But, in computer science areas our students are really doing some good job they are going for R&D sections. Recently one person who graduated in a

complexity theory went for this job, for example, in Dell systems. So, there are some areas like this where they are able to go, but it is really again a confine to the R&D sector. It's not going to the productive sector.

Prof. Prathap Haridoss: R&D sector.

Prof. Arindama Singh: In the industries.

Prof. Prathap Haridoss: But what about let's say I mean let's say the world associated with you know all these stack markets and things like that.

Prof. Arindama Singh: Yeah, Finance.

Prof. Prathap Haridoss: Finance.

Prof. Arindama Singh: We are not having any expertise in that.

Prof. Prathap Haridoss: OK.

Prof. Arindama Singh: There is nobody in actuarial sciences.

Prof. Prathap Haridoss: But.

Prof. Arindama Singh: That is one area where math 27 can be useful. But in abroad they are really.

Prof. Prathap Haridoss: Yeah, they seem to be using that I mean even from what I even say physicists and work not get absorbed by the financial sector because they seem to be doing a lot of analysis or I think the tools may be they learns are suitable for those kinds of positions. So, that is not something that you are saying.

Prof. Arindama Singh: That is not at (Refer Time: 09:21).

Prof. Prathap Haridoss: OK. You see just a there I mean is the just a not aware that there are enough people here with that kind of expertise.

Prof. Arindama Singh: We do not have expertise. In our department, for example, there is no person who is expert in the actuarial sensors.

Prof. Prathap Haridoss: OK, fine. Let us say in our experience which looking at students over all these years. In generally know in the institution we have some metrix of you know how people are progressing, what causes they have done, what grades they have got, what type of publication they made etcetera. But in generally, in a more holistic sense especially for someone who is just you know considering coming in and so on what would you suggest are good ways to measure their progress in research, so that for their own satisfaction also they understand in fact, they are progressing in research especially let's say with respect to mathematics for example, did you think there are ways in which they should think of themselves analyze their situations.

Prof. Arindama Singh: There is one objective factor which is well public essence in good journals.

Prof. Prathap Haridoss: OK.

Prof. Arindama Singh: So, though it looks very objective, there is objective factor in terming which one is good and which one is bad.

Prof. Prathap Haridoss: OK.

Prof. Arindama Singh: So, that is almost settled.

Prof. Prathap Haridoss: OK.

Prof. Arindama Singh: If you ask any general person whether this journal is good or not he will be able to tell you. Even he publishes in that he may say also it is bad enough.

Prof. Prathap Haridoss: OK.

Prof. Arindama Singh: So, there is some set of understanding.

Prof. Prathap Haridoss: Understanding.

Prof. Arindama Singh: So, number of papers that come in good journals that is a.

Prof. Prathap Haridoss: Good metric.

Prof. Arindama Singh: Well.

Prof. Prathap Haridoss: OK.

Prof. Arindama Singh: But individually when a person discusses with supervisor the supervisor knows how much progress he has taught.

Prof. Prathap Haridoss: OK.

Prof. Arindama Singh: About that, it's basically not only that area fair he is doing research, but the peripheral areas.

Prof. Prathap Haridoss: OK ok.

Prof. Arindama Singh: How much he has acquired about the null is about the peripherals.

Prof. Prathap Haridoss: OK.

Prof. Arindama Singh: So that after he finishes his PhD, he will be able to really do research on his own.

Prof. Prathap Haridoss: OK.

Prof. Arindama Singh: There are some measures like one publication there is a measure factor they are in the publications. So, one is whether somebody has solved a long stunning problem.

Prof. Prathap Haridoss: OK.

Prof. Arindama Singh: That is a good measure of thing or how far he has progressed towards that. Another is if he has not solved any long standing problem, whether he has done something which will give rise to a long standing problem.

Prof. Prathap Haridoss: Fine, either solved a long standing problem or created a long standing process.

Prof. Arindama Singh: Yes.

Prof. Prathap Haridoss: Problem there is stands for.

Prof. Arindama Singh: So, these are the two things which are very good.

Prof. Prathap Haridoss: OK ok.

Prof. Arindama Singh: And the third one is anyway we have to use always which is the number of the papers in good journals

Prof. Prathap Haridoss: Ok. So, these are some.

Prof. Arindama Singh: Yes.

Prof. Prathap Haridoss: In especially with respect to mathematics on a sort of a mundane thing concept you know when students come in they have come from a you know

academic setting where they do courses and so on, they come and they are now getting into research setting. Generally you know all areas of research we always feel that you know interaction is a very important, technical interaction is a very important way in which people grow as researchers and in that you know working with the people in the group, working with the guide, meeting the guide etcetera plays a very important role. In mathematics where you know there is a lot of thought processes involved, lot of you know it's a very in many ways a very internal thing we are not often not running an experiments sort of how important do you see this role of a student adviser meeting? How often should you think they should meet?

Prof. Arindama Singh: Ideally they should meet every day over coffee.

Prof. Prathap Haridoss: OK.

Prof. Arindama Singh: Because then mathematics do not have any labs, where they can interact with the things of the work.

Prof. Prathap Haridoss: OK.

Prof. Arindama Singh: It's really only communicative. It's a linguistic entity.

Prof. Prathap Haridoss: OK.

Prof. Arindama Singh: So, they have to go on communicative.

Prof. Prathap Haridoss: OK.

Prof. Arindama Singh: By that only they will get experience, there is no other way.

Prof. Prathap Haridoss: OK.

Prof. Arindama Singh: But what we find is usually they are giving some jobs and they come to meet the supervisor after one or two weeks. And then they spend 1 or 2 hours, get some ideas and go away.

Prof. Prathap Haridoss: OK.

Prof. Arindama Singh: That way it will not happen, mathematics will not happen.

Prof. Prathap Haridoss: OK.

Prof. Arindama Singh: But sometime you may need that seclusion because if some ideas really stuck you need certain answer time to get it into work.

Prof. Prathap Haridoss: OK.

Prof. Arindama Singh: So, sometimes it may be OK, but not always.

Prof. Prathap Haridoss: OK.

Prof. Arindama Singh: Ideally it should be everyday one should meet, tell something about what has happened. And then go back.

Prof. Prathap Haridoss: Ok ok and what sort of characteristic you think people should have to be good mathematicians, I mean in the sense how can how can someone you know of course, you have seen one is an inclination you tend to solve some problems and you feel comfortable with idea that I understand, but over and above that is there some visualization capability that you I mean what should a person see in themselves and say okay this I am able to do this, probably I am good at mathematics other than just being able to solve the problem.

Prof. Arindama Singh: Well, if you look at mathematicians there are all sorts of people in that community.

Prof. Prathap Haridoss: OK.

Prof. Arindama Singh: We cannot say that for mathematics one should be like these.

Prof. Prathap Haridoss: OK.

Prof. Arindama Singh: But certainly they are not fools.

Prof. Prathap Haridoss: OK.

Prof. Arindama Singh: That is one characteristic that they should be intelligent.

Prof. Prathap Haridoss: OK.

Prof. Arindama Singh: They should try to find out if there is something to go differ or not.

Prof. Prathap Haridoss: OK.

Prof. Arindama Singh: So that is one characteristic which really characterizes them.

Prof. Prathap Haridoss: OK.

Prof. Arindama Singh: There are not satisfied just looking at the surface. They would like to go deeper.

Prof. Prathap Haridoss: OK.

Prof. Arindama Singh: What is the pattern behind it?

Prof. Prathap Haridoss: Right.

Prof. Arindama Singh: See one has that interest. Then probably it can be happened.

Prof. Prathap Haridoss: OK.

Prof. Arindama Singh: But, if you doesn't have that interest he cannot be a mathematician.

Prof. Prathap Haridoss: So, that thing that you know you should not be a superficial thing.

Prof. Arindama Singh: Yes.

Prof. Prathap Haridoss: Okay much, much deeper into the thought process behind that the solution. What sort of I mean I know you touched upon this little bit, what sort of especially with you know in both certainly in engineering and I am sure in mathematics too when you say an MS or a PhD kind of a degree automatically the thinking is that this person is now an expert in a narrow area. So, there is some kind of a specialization associated with it. So, in that sense what sort of positions are people who create MS or PhD degrees from mathematics department and what sort of positions you see them going to in recent times and where do you think are the possibilities for such.

Prof. Arindama Singh: See at least from IITs when you get one PhD in mathematics, you do not expect him to be very narrow because there are associated with the tutorial classes with the B. Tech process.

Prof. Prathap Haridoss: OK.

Prof. Arindama Singh: So, they are having a lot bigger background than other process.

Prof. Prathap Haridoss: OK.

Prof. Arindama Singh: Where this HTTA concept is missing, probably there the students are also missing.

Prof. Prathap Haridoss: Those students are also missing. Ok, fine they are missing that. So, here it is a nice learning experience.

Prof. Arindama Singh: It is nice learning experience and they get firsthand experience of teaching also.

Prof. Prathap Haridoss: OK.

Prof. Arindama Singh: Have to communicate mathematics by Vernon communication. So, that is important they can write, but they are not able to speak sometimes.

Prof. Prathap Haridoss: OK.

Prof. Arindama Singh: So, this helps them to speak that way they are better compared to other process, but then that is not everything. So, they have to once they really narrowed down because IITs there are only 17 or 18 IITs and we get a less number of students compared to the other process. So, everywhere it is not possible. So, there, there is an expectation, they are narrowed down to some particular area, but then it should be possible for them to take up when the other thing later, because once that is what one person asked me once that if I come to do M. Sc here what will I gain, I am not going to get any job directly after M. Sc. So, at that time there was no job even in the market for the mathematics students. Now at least there are some employment for doing research or something at that time there is no possible term research also, very few places where having the research compositions. So, my typical answer was whatever job they go they will be able to do it.

Prof. Prathap Haridoss: OK.

Prof. Arindama Singh: Provided they have the interest.

Prof. Prathap Haridoss: OK.

Prof. Arindama Singh: So, these mathematicians pick up this nasty habit that they want to reinvent everything.

Prof. Prathap Haridoss: OK.

Prof. Arindama Singh: See, if something is done in the book. They will not be satisfied. They would like to do themselves again, though that will be a guideline.

Prof. Prathap Haridoss: OK.

Prof. Arindama Singh: So, this reinvention is also hated in some of the industries.

Prof. Prathap Haridoss: OK.

Prof. Arindama Singh: Because they have the particular process.

Prof. Prathap Haridoss: OK.

Prof. Arindama Singh: And if this person does'nt follow the process tries to topple with it or create problems then lot of things gets disturbed.

Prof. Prathap Haridoss: OK.

Prof. Arindama Singh: So, that is the only thing they have to be conscious, when they go to do any other job outside the academia.

Prof. Prathap Haridoss: OK, but what all.

Prof. Arindama Singh: But usually the position is academic position.

Prof. Prathap Haridoss: Academic position is the most teaching positions.

Prof. Arindama Singh: And then in industries R&D positions.

Prof. Prathap Haridoss: R&D position. These are the.

Prof. Arindama Singh: These are the best ones.

Prof. Prathap Haridoss: OK.

Prof. Arindama Singh: Best fitted for them really.

Prof. Prathap Haridoss: Okay Fine and okay may be a sort of enclosing I just wanted to get a sense of you know a lot of students I mean in fact, there are students who finish you know even high school who consider mathematics as a something that is very interested and passionate about maybe under grads who consider it in greater you know enthusiasm for it. Is there some, what sort of advise you would give for people who are aspiring to become MS and PhD students to go on to get higher degrees in mathematics, what sort of advise would give you them?

Prof. Arindama Singh: Well, once they do their M. Sc, just to able to find out in which area they are really interested, if they are really interested in some area they should be able to produce some such new things, which may not be very weak thing which expert sees in that area I will say it is nothing, but it should be a deviation from the usual curriculum.

Prof. Prathap Haridoss: OK.

Prof. Arindama Singh: One such a thing is there I would encourage him to go for doing research in mathematics. If it is not there then it may not be worth doing because I will do the usual things you will for teaching and so on.

Prof. Prathap Haridoss: OK.

Prof. Arindama Singh: But not we will be able to really contribute to mathematics.

Prof. Prathap Haridoss: So, you are saying this would be one nice way for them to gauge whether they are you know in the right process to be going ahead for.

Prof. Arindama Singh: Yes.

Prof. Prathap Haridoss: Higher degrees in mathematics.

Prof. Arindama Singh: Yes.

Prof. Prathap Haridoss: So, they would have to at least for small number of new things.

Prof. Arindama Singh: Yes.

Prof. Prathap Haridoss: They should start dabbling with, so that an expert feels that they are you know comfortable with that.

Prof. Arindama Singh: Yeah. So, you would like to see the playing thing that he really plays with mathematics.

Prof. Prathap Haridoss: OK.

Prof. Arindama Singh: Not only does the conventional things.

Prof. Prathap Haridoss: OK.

Prof. Arindama Singh: But he is very comfortable with it and he does something there.

Prof. Prathap Haridoss: OK ok. So, that is your advice, before he just jump in to an.

Prof. Arindama Singh: Yes.

Prof. Prathap Haridoss: Master degree or a PhD degree they should first gauge.

Prof. Arindama Singh: Yes.

Prof. Prathap Haridoss: Whether are you know sort of in the right frame of the mind for it and then on that basis proceed. Okay Thank you Dr. Arindama Singh.

Prof. Arindama Singh: Welcome.

Prof. Prathap Haridoss: Enjoyed meeting you and I think a very nice advise for, because mostly people we look at engineering students more often and think a lot of people considered mathematics, but they don't where to take it and I think these are nice words for advise for them to pointer about before they make their decisions and look at their life in graduate school here.

Thank you so much.