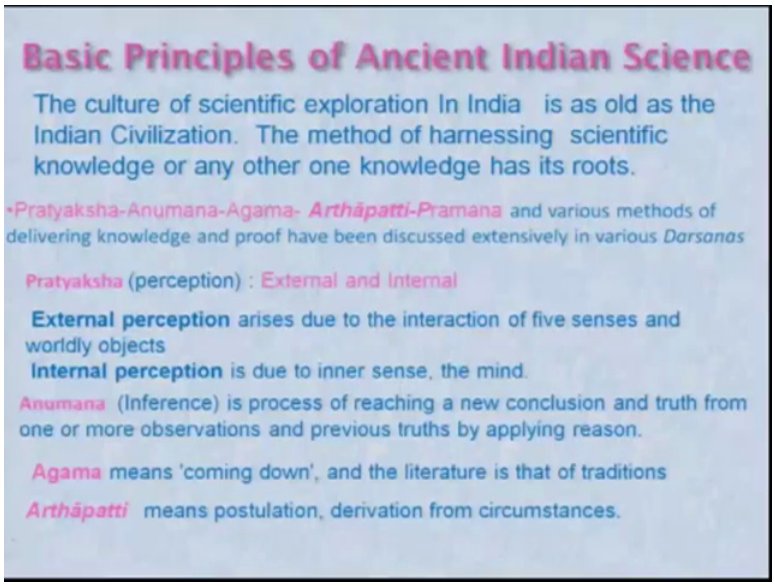
Introduction to Ancient Indian Technology
Professor D. P. Mishra
Department of Aerospace Engineering
Indian Institute of Technology
Module 2
Lecture No 06

Let us start this with a thought process – If you want to realize your potential, one must learn how not to get stopped by others. Every individual wants to realize his own potential. That is the what our scripture says you will have to realize your potential and you are infinite potentially. And it is a very great thought, we should keep in mind and then start this lecture.

Let us recapitulate what we learnt in the last lecture. If you recall that we started with the chronological. Some portion I could not cover in the last to last lecture about particularly from something around 1200 AD to 1800 CE, because I will be using in place of ADC that is common era. And later on, I went to the Vedic eras and we looked at you know various parts of the Vedas, Upavedas and also lot of other scriptures. And we looked at one very important thing, Shilpa Samhita which is having various ways of whole gamut of the engineering you know things what we are having.

(Refer Slide Time: 1:49)



Today, what we will be looking at is basically that how our ancestors were carrying out not only the science and other knowledge. They are harnessing the other knowledge, what are the ways? What are the basic principles they are they were using? Can anybody think of?

Because if you look at, ours is a very great living civilization I call. Most of the ancient civilization of other parts of the world is almost dead but ours is still living. It is about to die because of cultural invasion at this moment. We must see that we are alive and we are having a culture of scientific exploration which is as old as our Indian civilization. It is not that science was not there. Rather, science was there, it is intermingled with the spirituality.

We never had a quarrel between the religious leaders and the scientist like a….unlike in western part of the (coun) world. We are having all altogether. That is the samrasata that means you know same balance they were having. And the method of harnessing the scientific knowledge or any other form of knowledge has its deep roots. It is very…And if you look at, you will find that the modern way of doing science is similar if not same.

So you will be knowing most of them but I will talking about that in…If you look at, this is total the ways of doing is basically pratyaksha-anumana-agama- arthapatti and pramana, I think this terminology some of you might be aware. Pratyaksha means what? Pratyaksha means is basically perceptions, right? When how you will perceive?

It can be external. It can be internal, right? What do you mean by external perceptions? How you will perceive a thing? What are the basic tools you are endowed as a human being to do that? What are those things?

Student: Through what we call about senses like a….

Professor: Senses?

Student: Yeah.

Professor: We call in Hindi or in Sanskrit indriyas, you know. There is total 10 indriyas, karmendriyas and jnanendriyas, right? Karmendriya means hand, you know leg and then anus and then you know like genital, these are all karmendriyas. That this thing like your eyes, ears,

skins, right and nose, these are all sense organs. So by that you will basically get the perception, by these five senses for the worldly objects.

If I want to see, I want to observe, in modern science you want to do, you will have to do that with that help. Of course, nowadays you can have technology to aid your senses. That is all. But senses is the ultimate thing for a human being to perceive, to get the ideas, right?

But there is also internal perception. Internal perception you know you can think of mind. In Indian sense, mind is very vast thing. I do not want to get it, right? Like you might be knowing ahamkara, buddhi, chitta, right? And manas, these are all part. It is a very whole kind of concept. Mind is not only mind. Okay? That is a western way of looking at. But ours is a very profound thought process or the way of understanding.

So I will not get into that but I will tell you that inner sense…these are the external sensors what we are having. Inner sense I call it as a basically intuitive power, intuition. And the intuitive power man is endowed not animal and that cannot be…can be harnessed if you follow our ancestor way of teaching. Unfortunately, we are not. We must do that and the modern method of teaching or the you know education is far away from getting the intuitive knowledge.

I am not going to discuss that here but however intuitive knowledge is very important and once has to integrate it with the Mother Nature, then only you can get the intuitive power. And that is being you know…has to be utilized for harnessing the science, to understand, discover, to find out. And another way of doing is anumana what we call inference. Inference if you look at, it is basically you want to draw some conclusions but those conclusions which should have prior knowledge also. That we call as a inference.

And of course, you may have some observation, connect to the previous one whatever you are having, then connect it, that we call inference. And in loosely, one can say interpretation. We do interpret. And that we do in our sense, that is anumana. And it is very important to use your mind to have inference. People do not have time to think and then what about they will do inference drawing? They need mind to do that.

So in modern way, although we are using technology but we do not have peace of mind to think and draw inference, conduct experiment. You need perseverance. You need also good what you

call patience to do that. Scholarship cannot be obtained in a hurry. You want to be scholar, you will have to be patient, right? And lot of things.

So therefore the another way of doing is agama, meanings that whichever is coming down from the previous generation, you need to learn that and also understand that. That does not mean something wrong you will have to accept but you will have to check, verify it and then only you can say that is agama. It is a traditional knowledge what is coming up. What happened in India like you know with this western or the modernity, we lost all our things. We should not. Even right now also, we are losing our traditional knowledge at an alarming rate.

We should try to look at what there and our ancestors were having. We should take care of that and understand in a modern way. Not that we will have to you know be in that, no. The whole what you call world is in motion, that will be there also. It was there thousand years, is in motion, right? Flow, continuum today also. It will be there after thousand years but we need we will have to keep continuity. Continuity lost means you are lost. Am I right or wrong?

Continuity has to be maintained. So therefore we need to look at traditional knowledge and do that. And this is the agama is also tradition you know you will have look at. Do not throw that tradition because it is old, no. You are…you cannot afford to do that. So therefore we need to look at and those things you can use also for your way of interpreting or the this thing.

Then the arthapatti means a postulation. If you look at the word postulation and inference, it is almost similar, it is not same. So why there is another word? Can anybody tell me? Postulation means you (po) you know postulate something, you say something like you guess that what it would be, right? What would be the model? But then what is a difference? Can anybody tell me?

Difference is that in this case you get this postulation from a circumstances, from the evidence present. You are not taking the help of earlier knowledge. It is not that something on your back of mind and then you are trying to connect and guess. No, it is very raw, new. So therefore that is arthapatti. If you look at the what they are having, right? Even in modern time, we do not have that clarity.

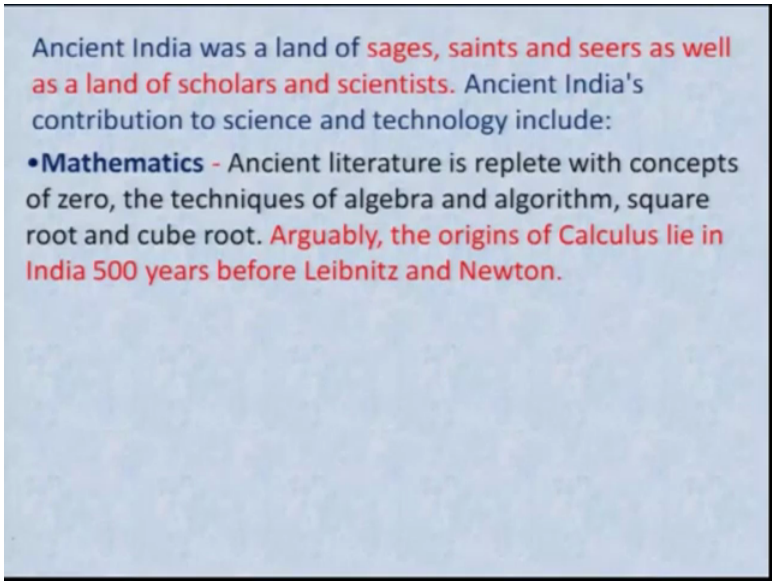
I am sure most of you may not be having. Am I right? But they were having, right? It is I am giving you tips of iceberg, you know there is a lot more to that. So it is not that only you will

inference, only you will speculate, only postulation. No, you will have to have proof. And we call it pramana. So proof means proof can be done various ways. You can have you know like somebody has told and you are getting experience, it is a proof.

You can conduct experiment and prove. There is a certain hypothesis is being talked about. The another fellow also think that way. You know like there is a various way of – you can give a logic and then prove from some other places like that we do in mathematics, right? Prove various ways. So therefore we always believe in proof. So this is the beauty of the ancient science and also the technology by which you know by the method by which they were harnessing the ancient science and technology.

It is not that you know believe something superstitious, no. So therefore you should think that they were doing. And as I told you the basic principle and you should use these principles also for harnessing modern science and whatever you do. It is not only science, for any other knowledge as a matter of fact. It should not be somebody has told and then you will believe, no. You will have to experience, you will have to interpret. You are a human being. You know you are having a….you want to garner the knowledge. So therefore this has to be followed.

(Refer Slide Time: 11:41)



So if you look at, ancient India was a land of sages, saints, seers as well as land of scholars and scientist. As I told earlier, the Bharat is Bha means knowledge. Rat means jo involve or indulge

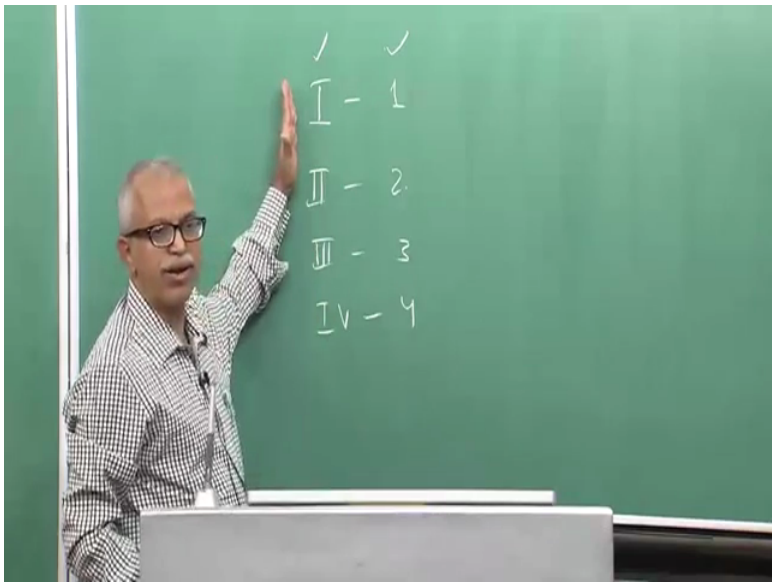
or doing, harnessing the knowledge. That is Bharat. Always we are having a knowledge society. Okay? The amount of knowledge what we have gathered, what we have given is enormous. Today we are not because we are following them blindly, right?

Then how can we do that? We can do only when you are having own and then you think independently and of course you can learn from other. So therefore ancient India's contribution to science and technology includes lot of thing, I will be giving a very short overview of that.

Mathematics, we are very good in mathematics although some of you will be frightened by the mathematics today. And as I told that concepts of zero is a great contribution to the world. The techniques of algebra, algorithm, square roots, cube roots and then you know like the calculus is from this place, lie in the India 500 years before the Leibnitz and Newton could think of. But unfortunately, in our school and colleges, that has been not talked about it. It is very unfortunate.

We should tell to our kids, to our youngsters that we our people were doing. And we must do that. We should come to their level. So what I was telling that this is the things what is very important.

(Refer Slide Time: 13:56)



For example, the if I say...if I ask people the numeral systems, for example, I, I means what? 1. II means 2, right? Or III means if I write it down….right? I, what is I? I basically 1, right. II, I call….right? III….okay? IV, 4. So if you look at, this is one (num) numeral system. There is

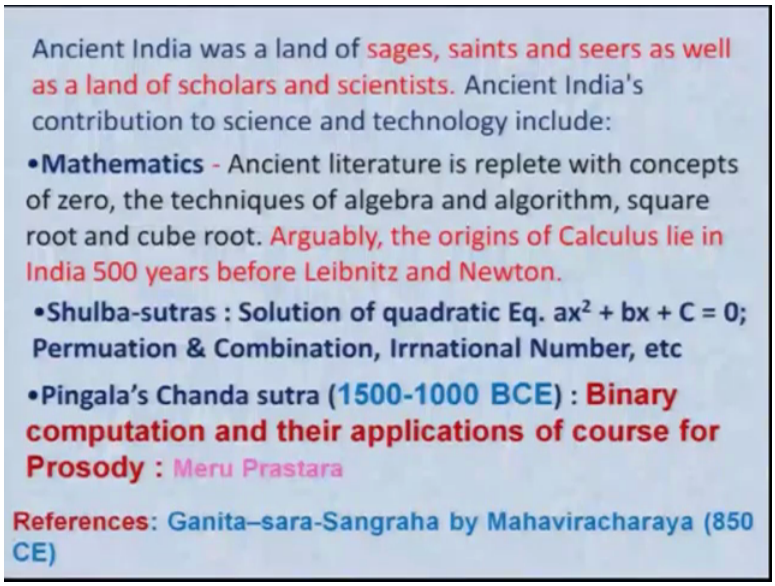
another, right? This is another numeral system. What you call this one? Roman numeral. What is this numeral system?

Student: Indo-Arabic.

Professor: Indo-Arabic, right. But very few people will be knowing that that is Indian. From India it is originated. When we are a kid, it was known as Arabic numerals. But now worldwide, it has been accepted. But my young friends, they do not know. We must tell to our people, "Look! We are the people who are our ancestors…we are means our ancestors have developed very beautiful numeral systems." Right? We should feel proud of it.

Not only proud of it but do something for our country and also the world. Am I right or wrong? So therefore lot of things we should I mean I have to convey. I have to do that and communicate to the our youngsters. That is the reason why I am taking so much of pain of doing this ancient Indian technology course. So you may not…may be aware Sulba-sutra which was very long time back, even like you know I have already given and they were having solution of quadratic equation what you use in your school times.

(Refer Slide Time: 14:47)

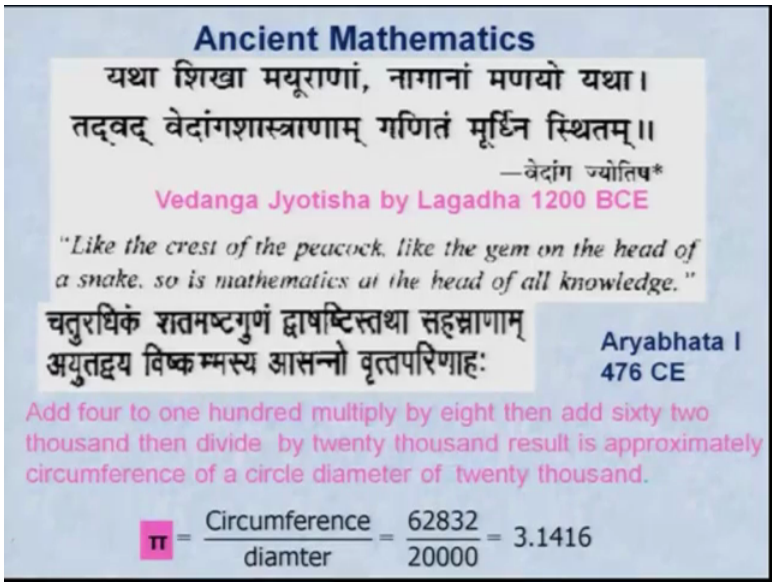


You know in the school it is being taught. But we never told it is from the Sulba-sutra, right? So also the permutation, combination, irrational numbers, as I told calculus, several other thing. You will be surprised to know that we use binary numbers. In computers, modeling binary number is

being used and it was there in our country by Pingala Chanda-sutra from something 1500 to 1000 BC, before Common Era. Before Common Era you know, from the Christ onwards is known as Common Era.

And before that, BC you call before Common Era. That means you know if 1500, around 2,000, 3,000, 500 years back you know. Are you getting? But that was not meant for computer application. It was meant for prosody. Prosody means you know poetry, chanda like I mean I will have to make it that way. And it was meant for spiritual, right? Our main base was that and you can see in Meru Prastara and other thing. But…

(Refer Slide Time: 16:26)



And if you want to look at this reference, you can see this Ganita-sara-sangraha by Mahaviracharaya, 800 CE, Common Eras. So if you look at, mathematics was considered to be the very important subject in ancient India but today our students are getting frightened by mathematics. Few might say, “Oh! It is difficult.” And it is you know like they feel a very shy about it. Why I am saying because it was used in Vedanga Jyotisha. This shloka I am taking from that in around 1200 BC, says, “Yatha shikha mayuranam, naganam manayo tath yatha. Tadvad vedangshastranam ganitam murdhinam sthitam.”

What is the meaning of that? Meaning is that like the crest of the peacock, like the gem on the head of a snake, so is the mathematics is head of all the knowledge. Mathematics is very

important for propagating the knowledge. Why? Why it is so? Actually, let me tell you our ancestors were aware that mathematics is the language by which you will express the science. You will be making it compact. You will do manipulation, calculation.

You know the way the what you call language helps us to develop our mind you know, you are aware or not? Because our language is very scientific. It helps to develop the intellectuality, the power of the mind not the English what I am using, okay? It is Sanskrit is the best language. Any other Indian language will be good because they are scientific. Similarly, mathematics helps to develop the mind and also to communicate well, right?

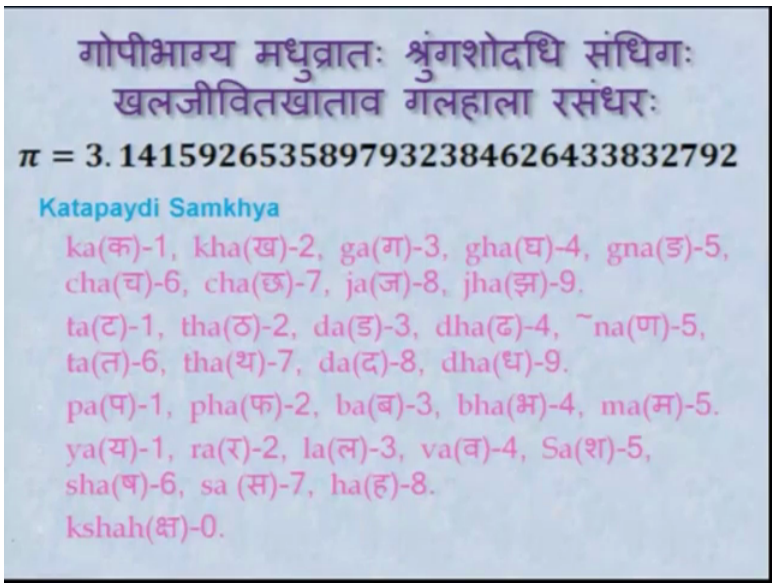
That is why mathematics is important and he has given….they have given…they had given the importance since you know like what you call some 3,000 years back even. So let us look at another shloka I am taking, "Chaturdhikam shatmashtagunam dwashshtitatha sahstranam ayutdwaya vishkamay aasnno vruttaparinah." Who gave this? This shloka is basically from Aryabhata I around 476 CE, Common Era. And what is the meaning of that?

That means he is saying add four to one hundred, multiply by eight then add sixty two thousands, then divide it by the twenty thousand, result is approximately circumference of a circle diameter by twenty thousand. By saying so, what is he trying to say? Do you know? Can anybody guess? It is the…..

Student: Value of Pi.

Professor: Value of Pi. See how they have put this thing in a very what you call simplified way and a language or a like a poem, a stanza of a poem. That means the literature, it was very profound in expressing the thing. So and it is one example I have given. There are several examples. I will not be really discussing all of them but I will be showing later on how the people were good in communicating or what you call in a little complex way. If you look at, it is a complex way. It is not that easy.

(Refer Slide Time: 19:57)



So I will give another very instances where cryptically people have talked about it. So therefore when you say that what is this, then you know we will we will lose amidst. Let us say this is the shloka like, “Gopibhagya madhuvrat shungashodadhi sandhigah khaljivitkhatava galhala rasandhar.” If you look at this shloka, is basically talking about Krishna, Shri Krishna. Gopibhagya means you know gopi jo hai unka bhagya hai, vidhata hai, raja hai. You know like he is a controller. But is it really so? That, we will look at.

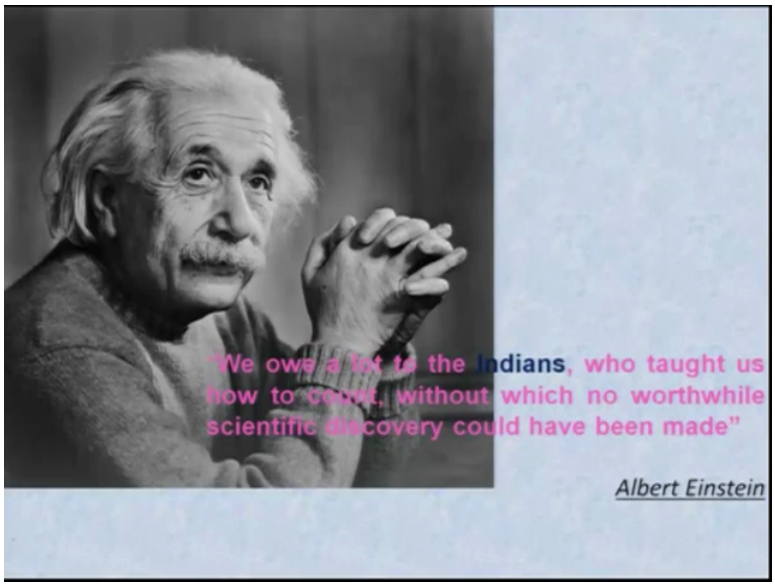
To unravel that, we will have to go the Katapaydi Samkhya. Katapaydi Samkhya, you some of you may be aware. That earlier days, what they give? They give a letter to a number. ka is 1, kha is 2, ga is 3, gha is 4, gna is 5, cha, chha, ja, jha, right? And ta, tha, da, dha, na, it goes that way. And pa, pha, ba, bha, ma, ya, ra, la, va, sha, ha and kshah. So if you look at, if I say ga, ga means what? 3. Pa, pa means what? 1. And if I say bha means? What is bha? Can anybody tell me? Bha is 4.

So if you go on putting that thing, you will…after that 5, okay? You will find the value of Pi which is correct up till the last digit. Can you please count how many are there? If you are having calculator, you can check. The number is correct till the last but one digit. So if you look at, what a wonderful thing! And we do not know how to decipher it, you know. Are you getting? There is a lot of things and we lost a lot of things. Something has gone we do not know.

So therefore you know like lot of scholars particularly from Arabian countries when they started taking our thing, they were startled. They say, “Why these people are doing that (())(22:10) complicated?” So and that the that also needs a level of thinking, level of expressing it you know. It is not easy to think and do that. So there is a lot of things which which are not connected but disconnected because history, we lost a lot of thing because of invasion, because of thousand years of foreign rule you know you can say.

And today also we are in that that colonial mind or the that slavery mindset. We have not come up. Hope that you people will do well and come up.

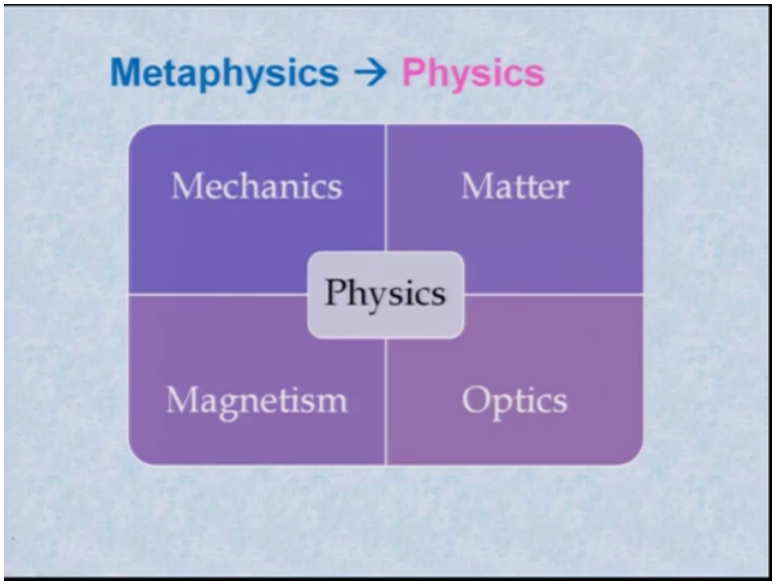
(Refer Slide Time: 22:49)



So of course, the Einstein I consider him, he is one of the greatest scientist so far this world has produced. And what he says? He says that we owe a lot to to the Indians who taught us how to count, without which no worthwhile scientific discovery could have been made. And he is confessing but whether we have that feel?

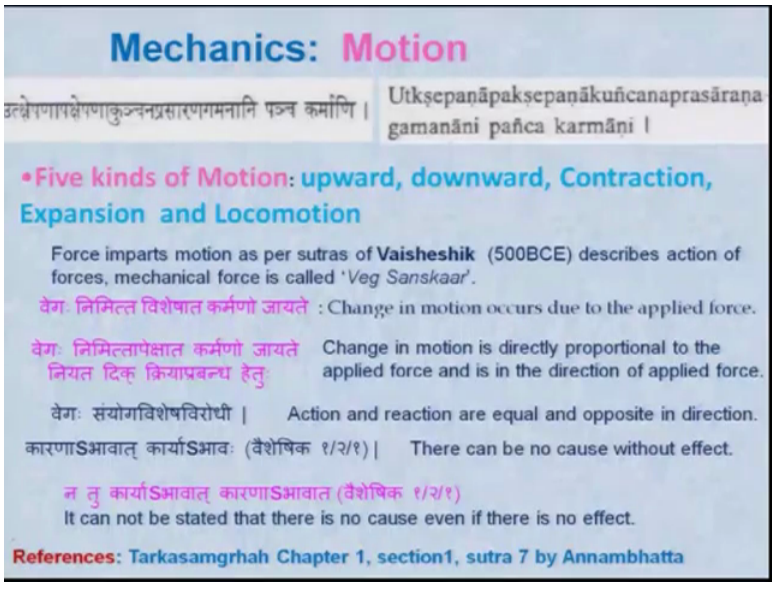
If we do not have feel that, then we cannot really progress because you should have conviction that our ancestors were good and we need to go beyond them. That is important, right? Then only we will be driving. So with this motivation, I would suggest that you please think about it and do well and see that all your potentially will come out of you and you will be useful to the not only yourself, for the society, for the world at large.

(Refer Slide Time: 23:48)



So if you look at, the physics generally comes from the metaphysics in India particularly you know. And you can…all aspect like mechanics, matter, magnetism and optics, I will be not talking very detail but however I will give try to glimpses of that.

(Refer Slide Time: 24:10)



For example, if you look at mechanics, this is a shloka, I will not recite it, “utkhepan prakshepan kunchan prasaran gamnani pancha karmani.” Karmani means basically is a motion like five kinds of motion: upward, downward, contraction, expansion, locomotion.

So similarly, let me now talk about that from the Vaisheshik which is something 500 BC. And there is a ‘Veg (sankar) Sanskaar’ sutra. Veg means, veg means velocity basically kind of thing you can think of, gati and describe the action of forces particularly mechanical forces, there might be electrical forces.

So veg nimitta visheshata visheshaat karmano jayate means change in motion occur due to applied force. If you look at, what is this? Can anybody tell me? Newton’s second law. But is it being taught to us? No, naa. Newton has told and this is 500 BC, right?

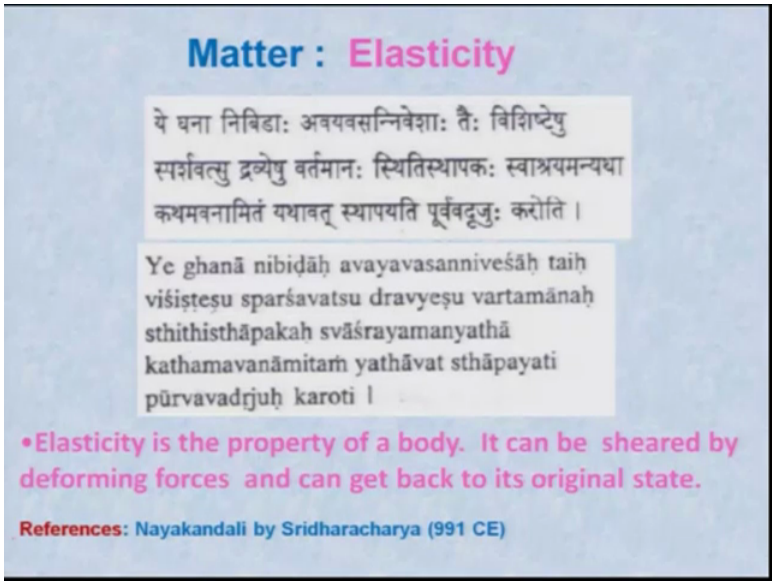
So veg nimitta pekshat karmano jayate, niyat dik kriyaprabandhan hetu that means change in motion is directly proportional to the applied force and is in direction of applied force, right? So it is more clear now that is the second law.

And veg sanyog vishesh virodhi, action and reaction are equal and opposite in direction; that is your third law of motion. And karanat bhavat karyabhah, there is a little problem, there can be no cause without effect. Right? That means something is there to have effect. But there is another thing, na tu karyabhavat karanabhavat, that means it cannot be stated that there is no cause even if there is no effect, right? He is saying that but again he is qualifying what should be, you know.

So what I am saying like we need to study these things, I mean these as bits and pieces. One has to relook at and look at from the perspective of what they were having. We are looking at from the perspective or the eyes of the western the way look. We need to look at both the eyes, it will be good so that you know we can get the better perspective than what our ancestors were having also, right?

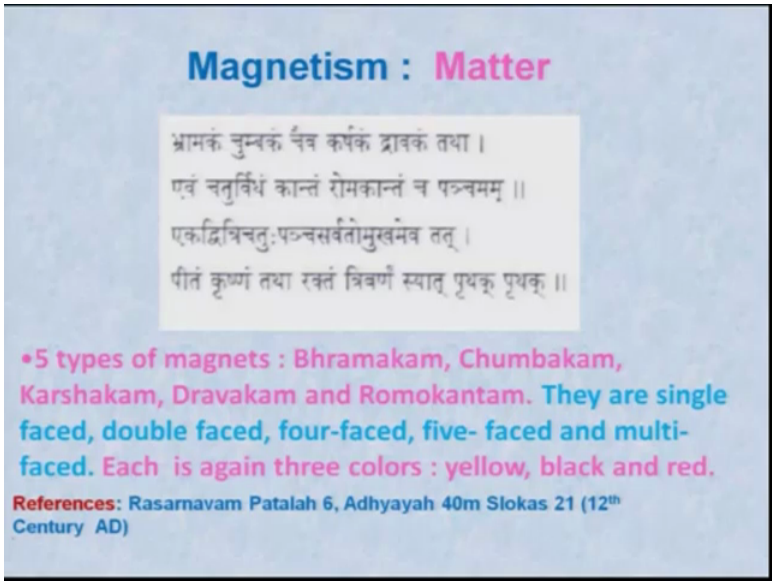
So this portion that is what you call force and other things what we have discussed is from the Vaisheshik but the five kinds of motion we have taken from Tarkasangraha Chapter 1 and then Annambhatta.

(Refer Slide Time: 26:54)



So similarly, elasticity I will not discuss about the shloka recite which is little complex, you may not get also. Of course, some of you may be knowing Sanskrit well. Ye ghana nibidah…..it goes on. That elasticity is the property of a body. That all of all of us experience you know like and also we have studied in our science you know school and colleges. It can be sheared by deforming forces, can get back to its original state. And this is Nayakandali by Sridharacharya in 991 CE. So if you look at, we are having something.

(Refer Slide Time: 27:36)



So similarly, magnetism or the matter like they call bhramaka chumbaka chaiva karshan dravakam tatha…..it goes on. So five types of magnets were there in ancient India: Bhramakam, Chumbakam, Karshakam, Dravakam, Romakantam. So these are varieties they have talked about and they are single-faced, double-faced, four-faced, five-faced, multi-faced. And each is again three colors. It can be yellow, black or red kind of thing. If you multiply all these thing, there will be several varieties of magnet you know they were aware.

So if you look at like we have now discussed about basically what are the basic principles of the methodology, how we can carry out the science or any scientific knowledge, we can harness. Beside this, we have looked at the what are the mathematics, little bit you know glimpses I have given. And now we are discussing about physics part portion.

And I will stop over here. And then we will be discussing the next lecture some portion of the physics and chemistry and then some other things. And then we will go on seeing even looking at games, what kind of games our ancestors had devised. So we will do that in next lecture. Thank you very much.