Computer Organization and Architecture: A Pedagogical Aspect

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Lecture – 01
Model of Computer and Working Principle

Ok welcome back to the course on computer organization and architecture. This is the first module of this particular course, before going to the course matters I slightly want to explain about the method of pedagogy and the outcome based learning because in this course we will follow the approach of outcome based learning.

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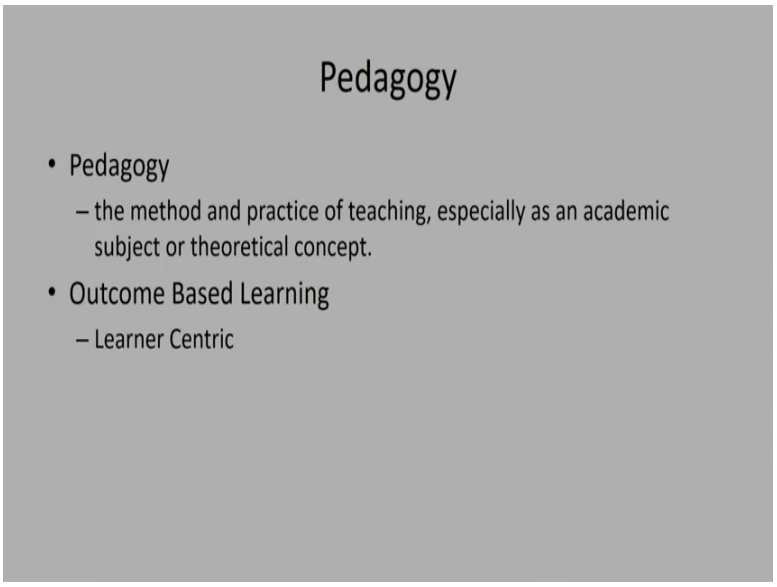

Now, first question arises what is pedagogy the dictionary meaning it says that the method and practice of teaching especially as an academic subject or theoretical concept. So this is the default definition of of pedagogy.

So this is a method of practice for teaching something in universities for theoretical subject and we will follow the outcome based learning and outcome based learning basically learner centric.

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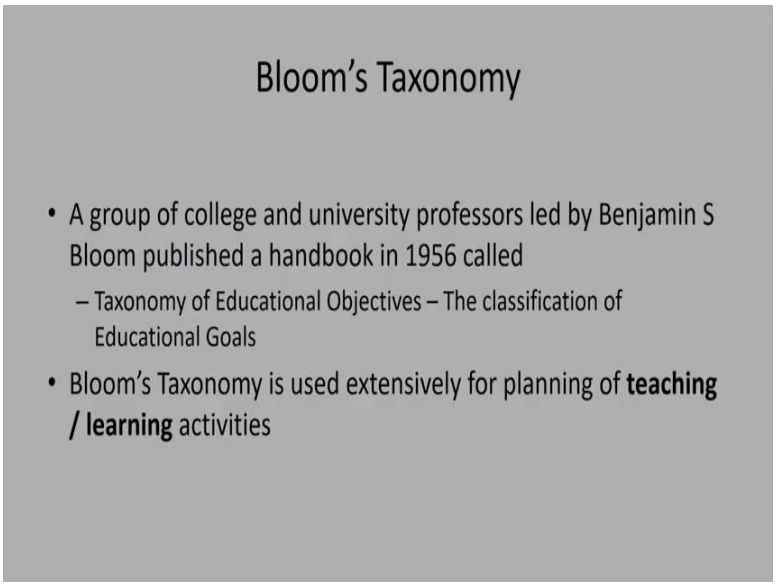

So the participation for the learner is most essential when we follow this particular outcome based learning. Now we talk about the teaching methodologies now we are teaching this in introduction form from long back, but people felt that there should be a proper mechanism or methodology to teach the student for a subject.

So for that reason a group of college and university professor led by Benjamin S Bloom published a handbook in 1956 called taxonomy of educational objectives the classification of educational goal, so bloom taxonomy use extensively for planning of teaching and learning objectives. So basically Bloom Taxonomy says about the planning of teaching and learning activities. So it is having 2 components one is teaching and another is learning. So we have to plan what instructor has to plan how to teach a subject and secondly, learner or the students have a plan how to learn the subject.

So in blooms taxonomy we define all those things and accordingly we try to deliver our lecture. So when we are going for the learning or when we are going to teach a subject basically all categories of learning can be categorized into 3 different domain as per blooms taxonomy these domains are cognitive domain, psychomotor domain and affective domain.

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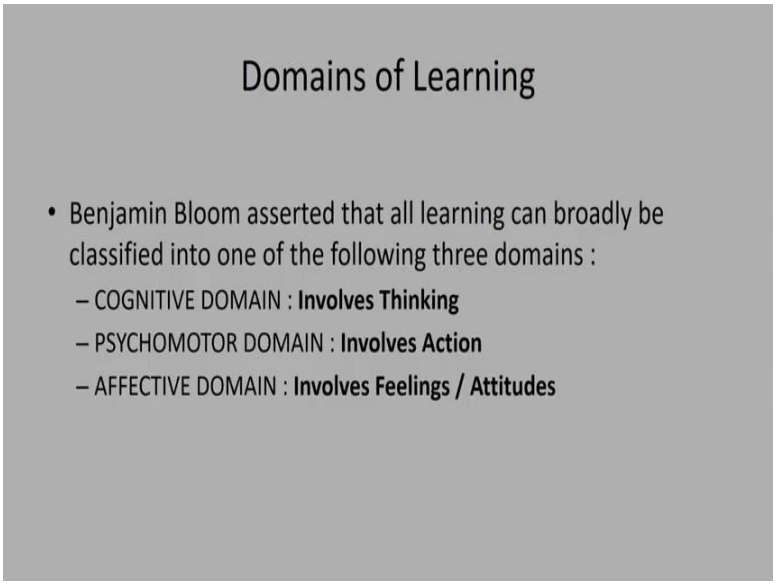

So in case of cognitive domain it involves thinking, so basically we are going to teach the student the subject matter so that we can generate the thinking process on the student there is a thing why it is happening and how it is going to solve in most of the higher learning activities we use that cognitive domain.

Another domain is your psychomotor domain which involve action basically these courses are mostly dominated by practicals you have to know how to handle an equipment how to take readings and how efficiently you can handle the equipment. So those issues are defined or addressed in psychomotor domain and another domain is your affective domain which involved feelings and attitudes. So we have to give some training to the students also how to handle a situation how to work with a team how to control his own sentiment all those things should be a part of this particular learning activities in this course or in the higher education mainly we concentrate on cognitive domain and cognitive domain is based on thinking skill.

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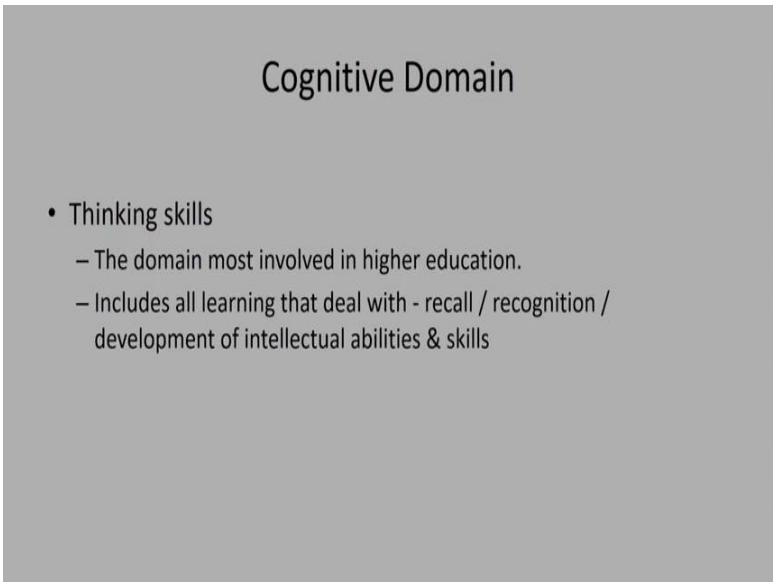

The domain most involved in higher education and it includes all the learning that deals with recall recognition and development of intellectual abilities and skill.

So basically that learning method basically talk about some recall of your earlier knowledge then recognize some situation and finally, develop the intellectual abilities and skill to solve the real life situation, so in cognitive domains we address those issues

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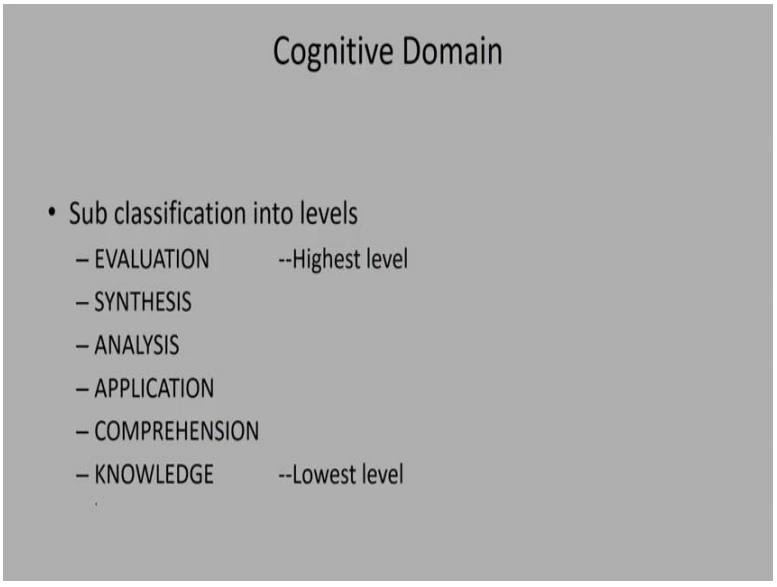

and in this course basically we are going to address mainly in the cognitive domain again there are some sub classification or levels in every domain. So in cognitive domain basically the sub classifications are in the lowest level it is knowledge.

So we will give some ideas in knowledge level which is required and after looking into the scenario you will be able to comprehend the situation and you can apply your knowledge this will go into the application level when you get a new scenario or new situation you will be able to analyze it depending on your knowledge and finally, what will happen it will be the design process basically you are able to design a new system which is the synthesizing the system and finally, you can evaluate the system.

So this is the from lowest level to highest level when a student or learner is in the highest level it is assumed that he has already mastered the lower level classes. So in this way while delivering our lectures we will indicate which portion has address in which level whether it is in application level or it is in design level. Now, in outcome based learning always you have to think about what is the outcome of the course.

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What the learners is going to accept after going through this particular course. In that particular case initially we are going to define the objective of the course and once we go through the course and once you complete the course we will make sure that all the objective will be achieved or all the objective will be met by the student. So first objective we are just looking into this where it is in the design phase or it is in the

synthesis level what we said that given a set of programming constructs categorize them according to their effect and design instruction for each category which can be implemented in hardware.

So it is a design objective our final objective is to design the computer system. Why you are going to design a computer system we are having some requirement first of all you have to identify those requirement and accordingly we have to come with a algorithm or you can say this is the programming construct, now whatever task we want to perform have to be categorized into different category and for each and every category we are going to define the operation or task. Finally, those operation will be implemented in hardware.

So we are going to meet this objective while go through this particular course. Objective 2 again it is in the design level, so what we are going to say given a set of specific instruction design an efficient CPU with hardware controlled and micro-programmed controlled methodologies. So basic objective objective 2 is a design of an efficient efficient CPU central processing unit and while we are going to design the processor we are going to look for 2 methodologies 1 methodology is called hardwired controlled and second method is called micro-programmed controlled methodologies. So we are going to address the design issues with the help of these 2 methodologies. So once we have met this objective then learner will design a processor either by hardwired controlled logic or micro-programmed controlled methodologies.

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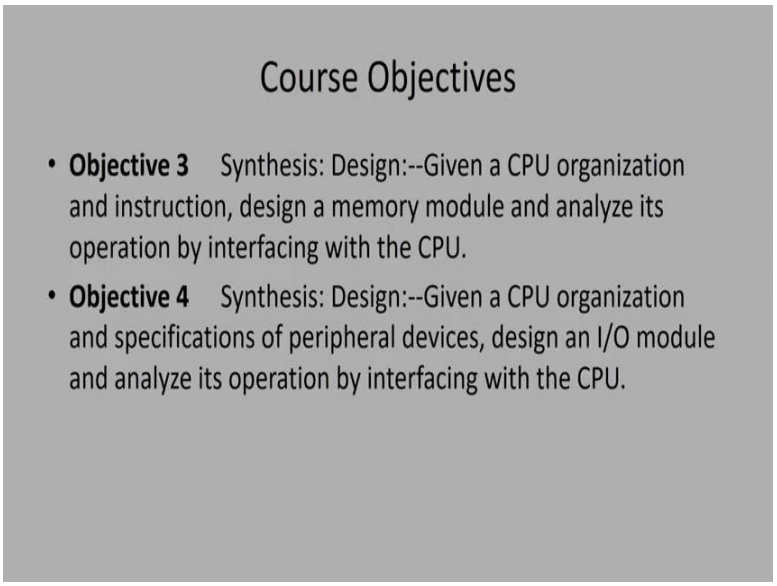

Objective 3 we are talking about again synthesis level or design issues given a CPU organization and instructions design a memory module and analyze its operation by interfacing with the CPU. So memory is also an important component in the processor we are going to with the objective how to design a memory unit and how to interface that particular memory unit with the processor. Objective 4 again it is in the synthesis level and design issues, given a CPU organization and specification of peripheral devices design an I/O module and analyze its operation by interfacing with CPU.

So computer will come up with some peripheral devices input output devices how to integrate those particular input output devices what are design issues we are going to discuss and we are going to meet this objective also while complete this particular course.

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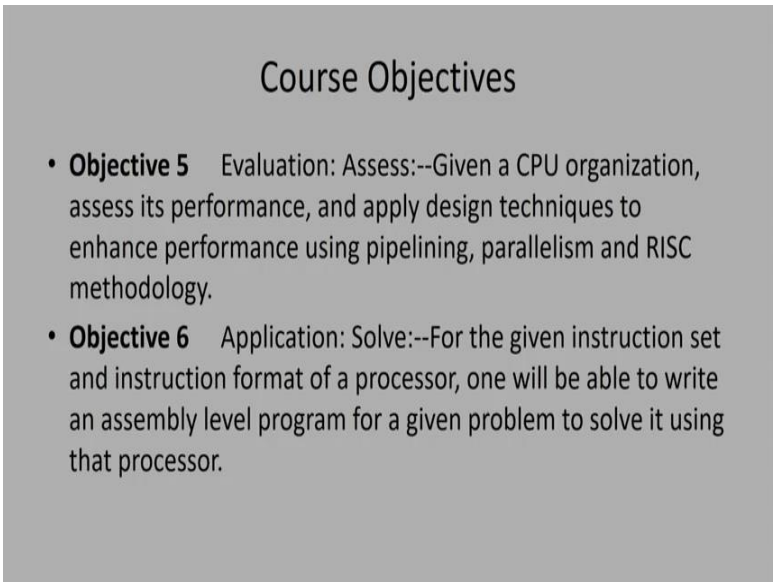

Objective 5 this is evaluation or performance evaluation you can say this is your assessment of our design it says that given a CPU organization asses its performance and apply design technique to enhance performance using pipelining, parallelism and RISC methodologies.

So while designing our processor there will be some issues or there is scope to improve the performance. So we are going to just evaluate it and we will address those issues only we are not going into the design process. The design process will be addressed in some high level course. Objective 6 we are talking about it is in the level of application or you can solve something what we are saying for a given instruction set and instruction format of a processor one will be able to write an assembly level program for a given problem to solve it using that processor. So if you look for any processor that is available and if you know the instruction set and instruction format then efficiently you will be able to write a program in assembly level to solve any problem, so this is in the application level.

So we are defining 6 objectives, we are defining 6 objectives for this particular course and throughout this particular course we are going to deliver a lecture in such a way that finally, we are going to meet all those particular objective. Now already we have mentioned that the course will be divided into several modules and the first module is fundamentals of digital computers.

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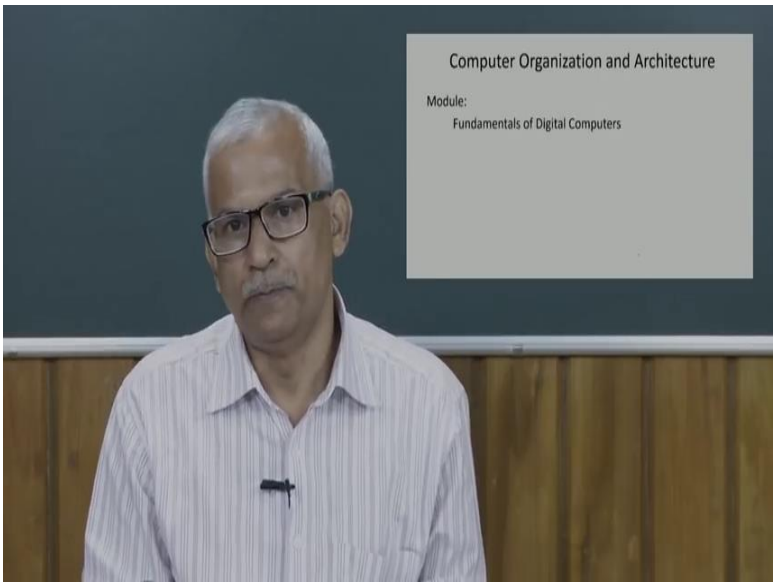

Now, what we are going to address in this particular module we are going to see basically we are going to now define the objective of this particular module.

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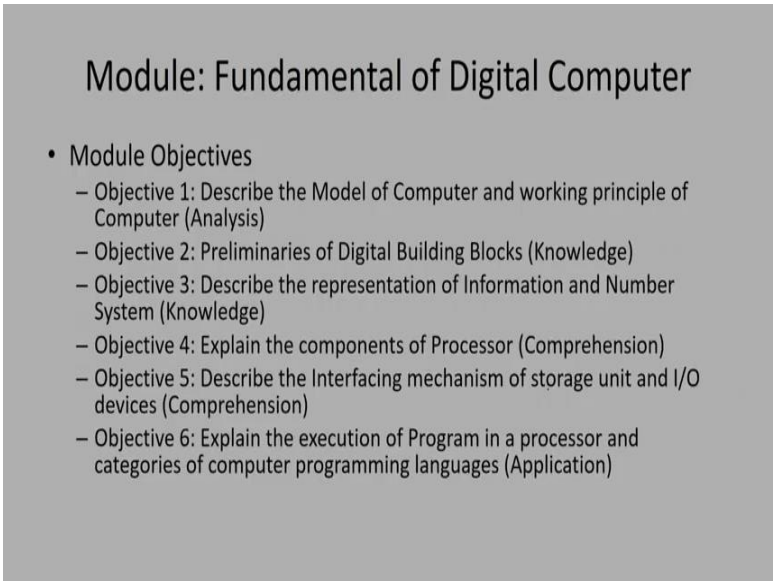

So what are the objective we are defining the objective like that.

Objective 1: describe the model of computer and working principle of computer. So this is basically in the analysis level, so how a computer works and what is the model we are going to accept once you meet this particular objective.

Objective 2: preliminaries of digital building blocks. So this is in the knowledge level so we need several digital blocks, we will simply give the introduction of those particular building blocks only. So it is in knowledge level once we have the knowledge of those particular component then we can use those things while designing our computer.

Objective 3: describe the representation of information and number system this is also in knowledge level, just we will mention how a information is represented in computer and how number system is used to represent all information. So see here we are defining these two things in your knowledge level, but if we are going to address them for example I am saying if we are going to address these digital building blocks in detail, then we are going to address these things in another subject in that particular subject we are going to address those particular issues in higher level maybe in the design level. So that is why we are saying that the prerequisite for this particular course is digital system. So once you have gone through this particular course then you will be knowing the details of this particular digital system. Here we will simply give knowledge level view and we are going to use those things.

Objective 4: explain the components of processor which is in the comprehension level. So here what we are going to see what are the components are there and how they are interconnected and once you see this thing that you will able comprehend how computer works. So this is in this module we are having these things in the comprehension level, but in subsequent module those issues will go into the design level because ultimately you have to know everything in details.

Objective 5: describe the interfacing mechanism of storage unit and I/O devices. So this is also in comprehension level. Memory is an integral part of our computer so here we are simply going to give the introduction and how you are going to connect it and how we are going to use it, but in another module we are going to address all those issues in details in details and it will be in the design level.

Objective 6: explain the execution of program in a processor and categories of computer programming language it is in application level. So we are going to give example also or we will illustrate it with example how a processor exactly executes a program. Here we are going to give the module learning strategy what is the strategy of learning this

particular module. So here basically we are going to give all the resources that will be used for these particular courses.

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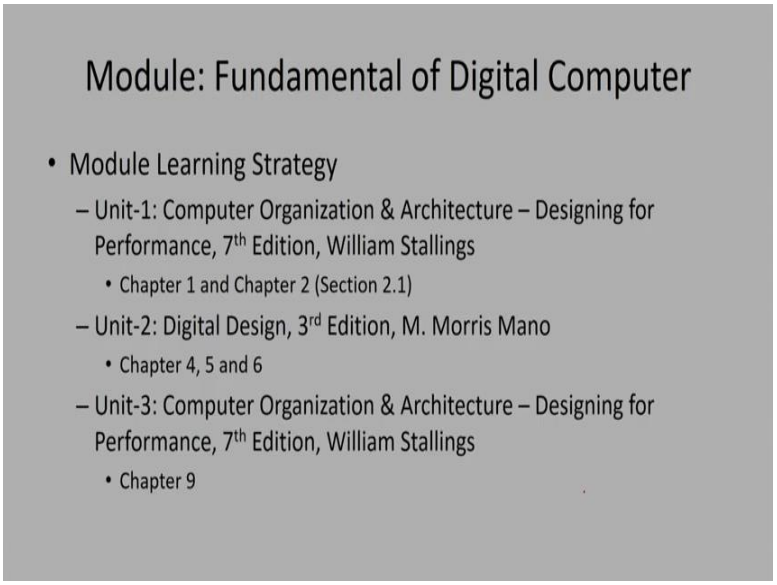

For unit 1 we are going to use the book Computer Organization and Architecture- Designing for performance. Just I am looking for the 7th edition of that particular book and it is written by William Stallings. So for this unit 1 you have to go through chapter 1 it is a very small chapter and section 2.1 of chapter 2. So if you go through simply read these particular materials then you will be able to understand what we are going to discuss about this thing and in my presentation I am going to use the materials from this particular book and some of the slides I have borrowed from the authors homepage also and some of the slides I have modified according to my convenience. For unit 2 the reference book is Digital Design third edition and author is M. Morris Mano. So here I am mentioning 4 chapters that is 3 chapters the chapter 4, 5 and 6.

So in those particular chapters detailed design issues are mentioned, but here we are going to address these things in knowledge level. So if you want to brush up then you can go through those particular chapters or if you are confident about those issues then you can skip these particular chapters. For unit 3 again I am going to use the book by Stallings Computer Organization and Architecture - Designing for performance and these are basically taken from the chapter 9 of that particular book. So for unit 4, 5 and 6 again I am using the same books the book written by William Stallings.

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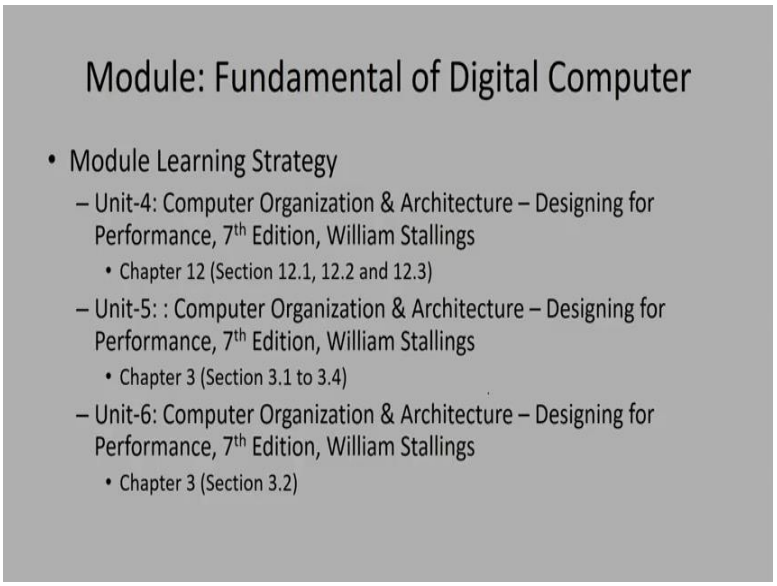

So for module unit 4 you have to look for the chapter 12 this is a section 12.1, 12 .2 and 12.3. For unit 5 I am taking some material from chapter 3 mainly sections from 3.1 to 3.4 and for unit 6 again I am using the same book again in the chapter 3 and this material is taken from chapter 3.2. So if you go through those particular section then it will be easier to follow my lectures. Now we have defined objective of our course, the course is divided into several modules and the first module is a fundamental of digital computer again this module is divided into several unit.

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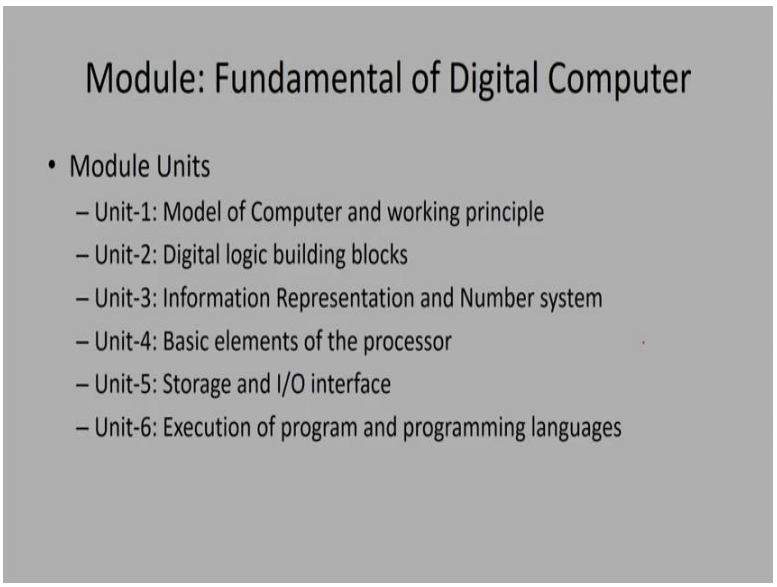

So what are the units we are dividing it with 6 unit first unit is model of computer and working principle, unit 2 is digital logic building blocks, unit 3 is information representation and number system, unit 4 basic elements of the processor, unit 5 storage and I/O interfaces and unit 6 execution of program and programming languages already I have mentioned about learning strategies. So you know what are the resources that we are going to use for those particular units.

Now unit 1 this is model of computers and working principle. So what are the objective of this particular module, objective 1: explain the working principle of computer again it is in the knowledge level describe the components of a computer it is in the comprehension level and objective 3 illustrate the evolution of computer it is in knowledge level.

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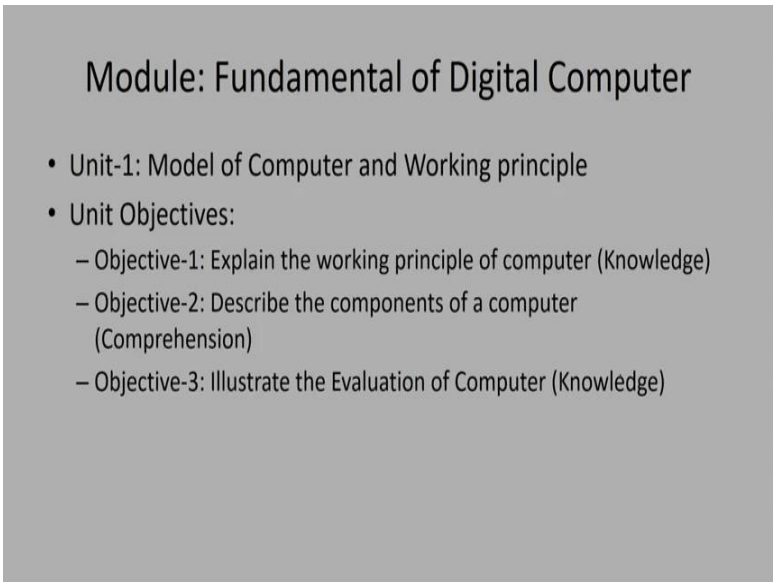

Currently you are most of you are working with a computer you have at least used the computer to browse the net send mails to your friend you are using some software to draft your letters and some of you might have used some compilers also to write program in high level languages compile it and then execute it.

So here reason the computer, but it is better to know how we have achieved this particular level today. So for that we are just simply going to brief idea about the evolution of computers also in this particular course. Now the name of the subject is computer organization and architecture. So in this course name itself we are having two

terms one is your architecture and second one is organization. So we are going to see what are the things that we are going to address in architecture and what are the things that we are going to address in organization.

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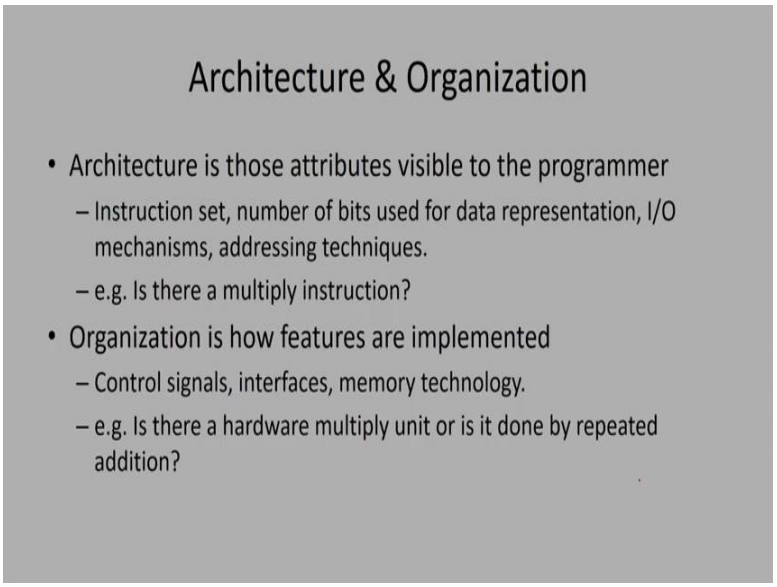

So in architecture we are going to say that architecture is those attributes visible to the programmer. So when you are going to use a computer you are going to solve your problem and you know that to solve this problem you have to have some operation or instruction. So, these instructions are visible to the user. So these are the issues which are visible to the users are basically addressed in the architecture. So basically what we are going to address in architecture what is the instruction set that means what are instructions that we have in the particular computer. What is the format of instruction each and every instruction should have a format and we have to adhere to this particular format and we are going to design all those things in the architecture level and we have to handle our I/O devices which way or what are the instructions that we have to handle those particular I/O devices will also be addressed in the architecture level.

So once you freeze the architectures then what will happen now we will go for the implementation which is the organizational view. For example, here I am saying that is there a multiply instruction so when we are going to design an instruction set we will see that whether multiplication is required or not and whether we are going to put a multiplication instruction or not. If you feel that we have to put a multiplication

instruction then in the architecture level itself we are going to freeze it we will say this is an instruction of our instruction set and the format of the instruction also we are going to specify. Now when we go to the organization it says that how we are going to implement those particular features that already we have defined in our architecture.

So we need to generate several control signals, so how to generate those particular control signal how we are going to place the component all those things will be discussed in the organizational issues. Here one example I am giving say is there a hardware multiply unit or is it done by repeated addition.

Now, you just say that when we said in my processor we are going to put a multiplier or we are going to put a multiplication instruction. Now how we are going to implement it, we are having several algorithms and most of you might be knowing that we are having an algorithm called Booths algorithm by which we can multiply 2 numbers. That Booths algorithms can be implemented in hardware and we can put that particular multiplier unit this is one way of implementing of multiplication.

But another way also we can look into that we are having an additional instruction we can use that additional instruction to get the effect of multiplication which is known as your repeated addition. Say for example, if I want to multiply 5 by 7 5 × 7 then what we can do I can add 5 7 times. So this is called done by repeated addition now this is a organizational issue we have to freeze it what way we are going to do it. So if I am going to implement it hardware one issue is like that we are going to get a faster response, but if in what cost, if we are going to use the repeated addition then system will be slow, but we may save cost. These are issues we are going to address or freeze in our organizational issues. Now again when going to look into the organization and architecture mainly in architecture we are going to get a families of architecture like that one family is known as your Intel x86.

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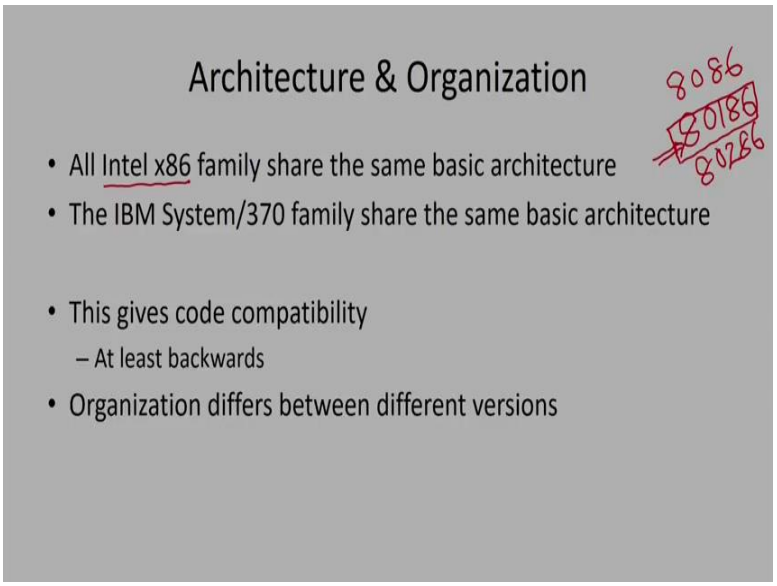

So in the particular case Intel x86 what we will have we are having a common architecture. First we have the processor called 8086. So we are having some instruction set and we know the instruction format then what Intel has done they have enhanced the instruction and going to 80186 like that they have gone for 80286 like that they are enhancing the instruction set. So this is called a family concept similarly IBM is also having family system called 370 family. So what is the advantage of these things it gives a code compatibility and it says at least backward.

Now, what does it mean say if you are having a software or we have written a program in your 80186 it is executed or it can execute this particular program in 80186, now Intel has enhanced this processor to 80286 what does it means that means, they have written the earlier instruction and along with that they gave us some more instruction to solve our problem.

So whatever instruction is there in your 186 all are available in 286, but along with that we are having some more additional instruction. So whatever software we have developed in 186 they can run in 286 also because all those instructions are available. So we said this is at least backward compatibility, but if you are writing a new program in 286 it may not run in 186 because some of the instructions may not be available in 186.

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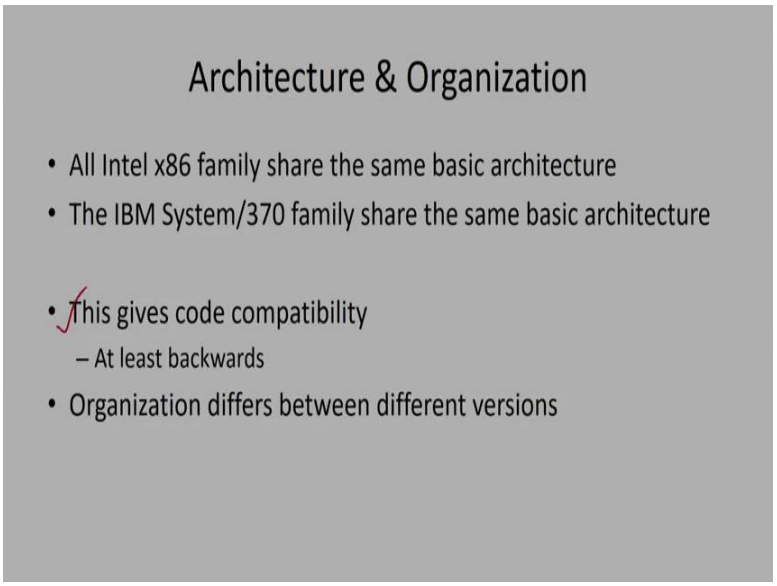

So in the family structure or family organization one is your code compatibility there is another issues we are having that organization differs between different versions. So basically if you look into the Intel product you know that there is a processor called Pentium again Pentium has two versions one called Pentium pro and second one is your Celeron. So if you go for particular Pentium processor you will find that the architecture of the Pentium and the architecture of Celeron are same, but they defer in organization. So that way you are putting a component it is different in Pentium pro or it is different in Celeron. That is why it says that organization differs between different versions. So company releases different version that defer in organization, but architecture is same. So all software will run in both the processors, but since organization is different so there may be some issues on performance one may have better performance than the other.