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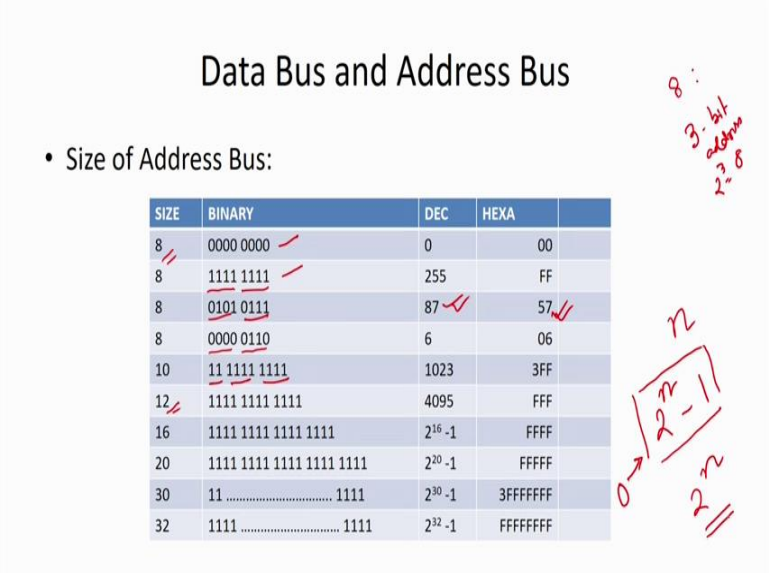

Like that; now I am just elaborating it now if the size of the address bus is 8, then what will happen? These contents will go from all zeros to all ones these are the different possible combination and in decimal we are saying that this is 0 or 255 that; that means, we can address 256 memory location if the size of the address bus is your 8 and this is 255 and here I am just writing it in hexadecimal, because I said that you take 4 bit together and thus get the hexadecimal equivalent, so this is your F.

Now, if I am having 8 bit address bus and the content is something like that 01010111. So, if I have this particular contents then the decimal equivalent of this one is your 87; that means, we are looking for the 87th memory location which is starting from 0 8, so we are going to 87 my location and found a particular memory location we are going to a take the data or we are going to write data. So, that same information that you can write in hexadecimal we can say that 57 hexadecimal, so this is 5 this is 7.

So, if the contents of the address bus is your and 000 and 110 so; that means this is 6, this is decimal 6 also in hexadecimal also it is 6; that means, we are looking for the 6th memory location. So, like that we are having total 256 combinations, so we can address 256 memory locations.

Like that if I am going to increase the size of the address bus to 10 then what will happen? It will become now 2^10 which is your; 1023, or in hexadecimal I am saying that this is 3FF, so it will go from memory location 0 to memory location 1023. If we increase the size of memory address bus to 12 then we can go up to 4095 like that if I am having a 16 bit address bus, then we can go up to 2^{16} - 1 so; that means, if I am having an n bit address bus then I can go up to 2^n - 1 memory location. So, total 2^n memory location it will go from 0 to 2^n- 1, so 2^n memory location we can address. So, the size of the memory module that we can connect to the processor depends on the size of the address bus.

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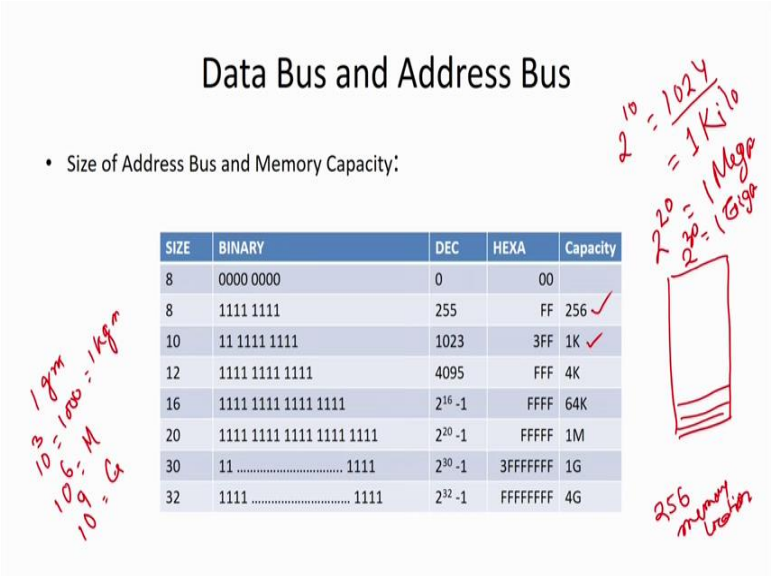

So, now we are talking about address bus this is the same slide, but along with that we are talking about the, what is the capacity? Now if it is size is your 8 bit then total memory capacity is 2^8, 256; that means we are having 256 memory location. We are talking about these are the location and this is your 256 memory location. We are not talking exactly how many bits we are storing over here, but we are storing saying that we are having 256 memory locations.

So, similarly if I am having a 10 bit then it is 1k actually 2^{10} is nothing but 1024, so in that particular case that 1024 memory location is basically written as 1 kilo memory location. Ok so, this is you just see that 1k means, 1024 which is your 2^{10}, so this is having slight difference with our metric system basically what will happen? If I am giving one gram one centimetre and then what will happen? I can say that 10^3 = 1000, so we are going to say this is your 1 kilogram.

Like that we are having 10^6, 10^9 which is your kilo, mega and here it is your Giga like that megahertz, Gigahertz like that. So, in metric system we are having 10^3, 10^6, 10^9, but in a binary system when we talk about the computer than 1k is your 1024 which is slightly more than 1000 ok slightly more than a metric system, like that 2^{20} is known as a your 1 mega and similarly 2^{30} is known as your 1 Giga, ok so this is the information or we are having it.

Now how we are going to specify our memory? Whether it is your mega location or Giga location or kilo location, now you just see that sometimes you used to say that, in your memory we are having 4 gigabyte of memory what does it means? We will see these things we will explain it, so this is the scenario and secondly what about the data bus?

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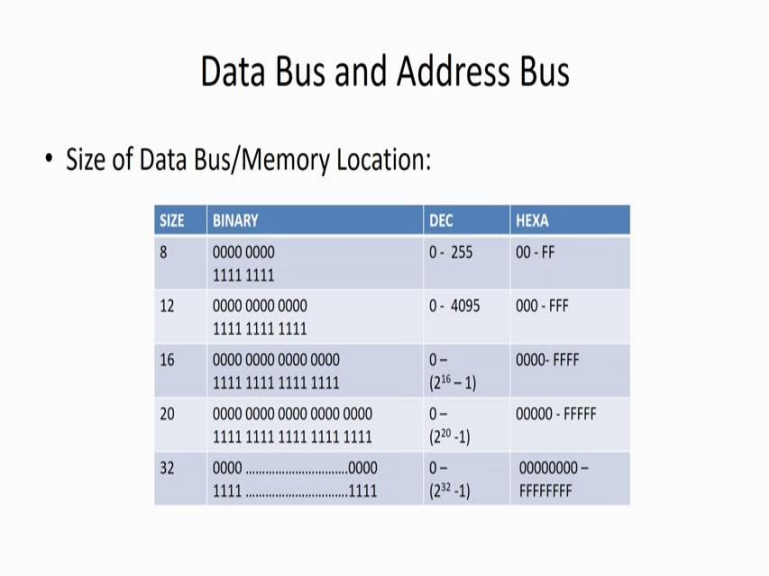

So, this is the same thing if I am going to have a data bus of 8 bit then I can go up to 0 to 255, if it is your 16 bit, I can go up to 0 to 2^{16} - 1 when we are talking about the number system at that time we have discussed all those issues. So, now you just see that, what is the relationship between them?

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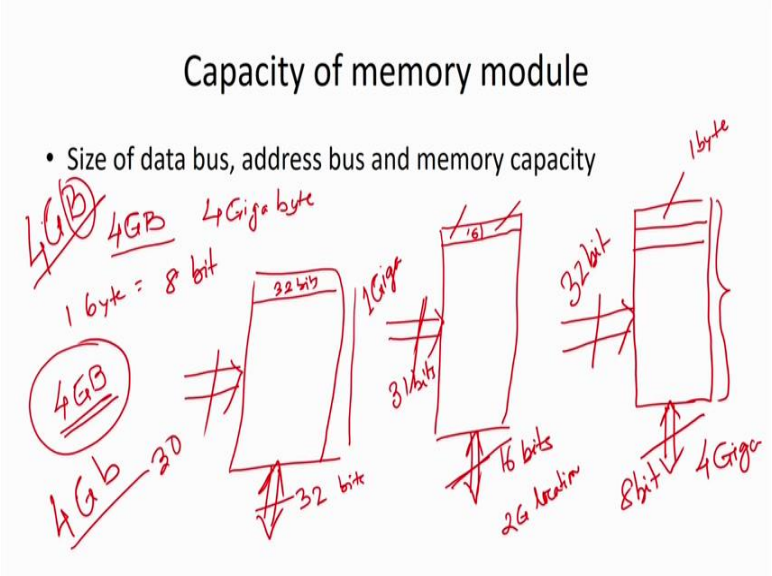

So, we have mentioned that you are having a computer with 4 Giga GB. We generally say that I am having memory that my computer is having 4 GB memory, so it means it is having 4 Gigabyte. What is byte? I think somewhere we have mentioned 1 byte = 8 bit, so if we take 8 bit together generally we call 1 byte. So, it is having 4 Gigabyte; that means, we can say that in a simple case what I can think that it is having 4 Gigabyte and I say that, in every memory location I am going to store 1 byte of information.

Then how many memory location we are having over here? 4 Giga memory location. Ok so see, we are having 4 Giga memory locations and in every memory location we are storing 1 byte of information. So, for that now if I am going to look into it, what is the size of this data bus over here? Since every memory location we are storing 1 bit of information 1 byte of information; that means, here I am having 8 bit, so data bus size of the data bus is your 8 bit.

Now what is the size of the address bus? So, you just see that I am telling you with 3 bit I can address 8 location, 4 bit we can address 16 location, 5 bit we can address 32 location, like that; if I am having your 10 bit of information 1 kilo, 20 bit of information 1 mega, so 30 bit of information 1 Giga 2^{30} and 4 Giga is your 2^{32}; that means, we need 32 bit over here.

So that means, if I say that I am having computer with the memory capacity is 4 Gigabyte basically we can visualize in this particular way, that it is having 32 bit of address bus and 8 bit of data bus and we are having total 4 Giga memory location and in every memory location I can store 8 bit of information, but again I can consider about the 4 Gigabyte of memory

location, but depending on the organization what will happen? The size of data bus and size of address bus will vary. So, 4 Giga byte I am talking about that memory capacity is 4 Gigabyte, but we are not mentioning our how many memory location is there, now if I am going to look this in that particular way that in every memory location I am going to store 16 bit of information, then data bus is your 16 bits ok, now here in every memory location now I am going to store 2 byte ok, since every memory location we are going to store 2 byte. So, the number of memory location that we have over here will be reduced by 2, so here I am going to have 2 Giga locations. So, in 2 Giga locations in every location I am using storing 2 bytes of information, so finally we are going to get 4 Gigabyte of memory.

So, since now I am having only 2 Giga memory locations then size of this address bus is your 31 bit ok, now again I am going to consider a memory module with 4 Gigabyte capacity but organisation is different, so in that particular organisation, what will happen? I can say that the size of my data bus is your say 32 bits. So, in that particular case; that means, in every memory location I can store 30 bits of information, now since it is 4 Gigabyte and in one memory location I am storing 32 bits that means, I am storing 4 byte since in one memory location I am saving 4 bytes. So, what will be the total number of memory location? We will find that this is your 1 Giga locations, 1 Giga × 4 byte will give 4 Gigabyte. Now to address 1 Giga memory location, what will be the size of this particular address bus? Now we can very well find it out this is your 30^{30} = 1 Giga. So, you just see that if I am going to talk about that I am having a computer with memory 4 Gigabyte then we have to see what is the processor size? Basically, whether it is a 32 bit processor or whether it is a 64 bit processor and depending on that we can find out that addresses and data bus. Again we are having some more concept called this is byte addressable; that means, though I am having 2 byte in one memory location we can address byte wise also I can take 8 bit and 8 bit, if I go into that one and what will happen? Sizes of address bus will be slightly different we have to recalculate it again it will turn up to be with 32 only, so when we are going to discuss about the memory module then at that time we are going to emphasise on that particular issue.

So, now you just see that we are going to connect a memory module to our processor that memory module is having some capacity; we can say it is a, 4 Gigabyte or 2 Gigabyte or may be say 4 megabyte, 256 megabyte and depending on the way that we are storing information; that means, size of the memory location with respect to that we can find out what is the size of the data bus? And what is the size of the address bus? So, these are the things that we are

discussing over here, so what we are talking about? That processor is the basically connected to memory unit and I/O devices through system bus, system bus is having 3 part; one is your address bus, data bus and control bus and depending on the now by looking into the size of the address bus we can find out what is the maximum size or memory that we can connect to that particular processor?

So, if I am having an address bus of 32 bit; that means, we can connect a memory to the processor where we can have 2^{32} which is 4 Giga memory location and depending on size of the data bus we can say how many bit we can store in a particular memory location. So, this is basically connecting the other components with the processor to build a full computer, so now just see that we have now discussed all those things now try to work out some work example or test item.

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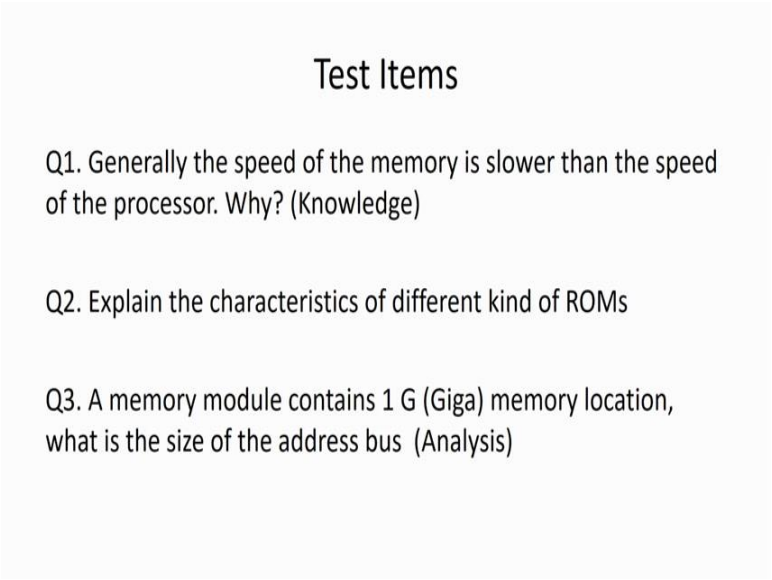

So, first question that I mentioned over here that generally speed of the memory is slower than the speed of the processor why? So, it is in knowledge level only because we have mentioned this thing in knowledge level, because to reduce the cost of the computers and then what will happen? We use different technologies to build different component and the technology that we used to build a memory module is a slower technology, so that's why the speed is slower. So, basically to balance the cost actually we need the performance as well as we want to reduce the cost, so for that we are coming with a slower device and due to that what will happen? The speed of the memory is slow.

Question number 2: I am saying that explain the characteristics of different kind of ROM's already I have mention that we are having ROM, PROM, EPROM, EEPROM, so these are the and you know what are the characteristic, one common characteristic all are non-volatile, but they are having some other characteristics also so I think you can note it down and you can write it down.

Question number 3: A memory module contains 1 Giga memory location, what is the size of the address bus? So, it is in analysis level I am talking about memory model contains 1 Giga memory location; that means, we should have a provision to address 1 Giga memory location.

Here we are not talking about the capacity of the memory module we are not saying that is 1 Gigabyte we are talking about 1 Giga memory location. Now what will be the total size? It depends on the information that we are storing in its memory location, if we are storing 1 byte then this is your 1 Gigabyte, if you are storing only 1 bit of information in your every memory location then capacity of this memory module will be 1 Giga bit. So, if we are storing 2 bytes of information in each memory location then the total capacity of memory module will be 2 Gigabyte. So, we are taking out 1 Giga memory location. So, what is the size of the address bus? I think you know it is 2^{30} = 1 Gigabyte, so size of the address bus will be your 30.

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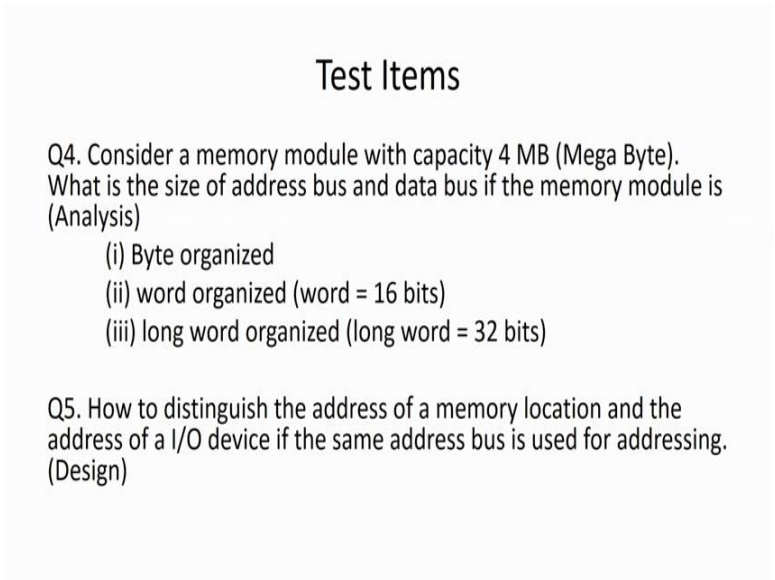

Now consider a memory location with capacity 4 MB, 4 megabyte. Ok so here I should mention one thing if I say 4 GB it means that 4 Gigabyte, but if I write 4G and lowercase b in that case it is a 4 Giga bit. So, this uppercase talk about the byte and this lowercase talk about the bit, now

this test item says that consider memory module with capacity 4 megabyte what is the size of the address bus and data bus if the memory module is? Ok this in the analysis level. So if it is byte organized; that means, in every location we are going to store 1 byte of information then what will be the size of address bus and data bus? If it is word organized that means one word is equal to 16 bit that we are storing 2 bits of information.

So, depending on that size of the address bus and size of the data bus will change. Third one: I am saying that long word organised; that means, one long word is equal to 32 bits; that means, 4 bytes in one memory location we can fit 32 bit of address, but total memory capacity is 4 megabyte. So, with respect to that you have to identify what is the size of the address bus and what is the size of the data bus?

Question number 5: How to distinguish the address of a memory location and the address of an I/O device, if the same address bus is used for addressing, so this is some high-level in the design level. So when we are going to design a computer at that time we have to resolve all those particular issue. I think I have mentioned something now we are using the same address bus, but at some point of time we are going to place the address of the memory location, at some other point we are going to put address of the a I/O devices. So, we have to distinguish this particular address so for that I think we need one additional control signal.

So, with the help of an additional signal we can say, what is the content of this particular address bus? So, this is basically I am just saying that is in the design level, because while you are going to design a processor you have to resolve this issue at the particular time itself. So, like that you can now try out with some other example also and with this I will wind up this particular unit. Ok so, hope you have you understood the methods over here.

Thank you very much.