Laser: Fundamentals and Applications
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Lecture – 40
Laser safety and summary

Hello and welcome. So, today is the last day of this course. So, today I will be talking about one very important aspect dealing with laser is the laser safety.

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You know laser has lot of advantages, but you know there may be a lot of you know a possibilities of you know accidents while using laser. So, one needs to be really you know well aware of the sources of hazards that are possible when one uses lasers. So, in order to know that we need to know what are the different classes of laser, so depending on their you know damaging power the lasers are classified under several categories.

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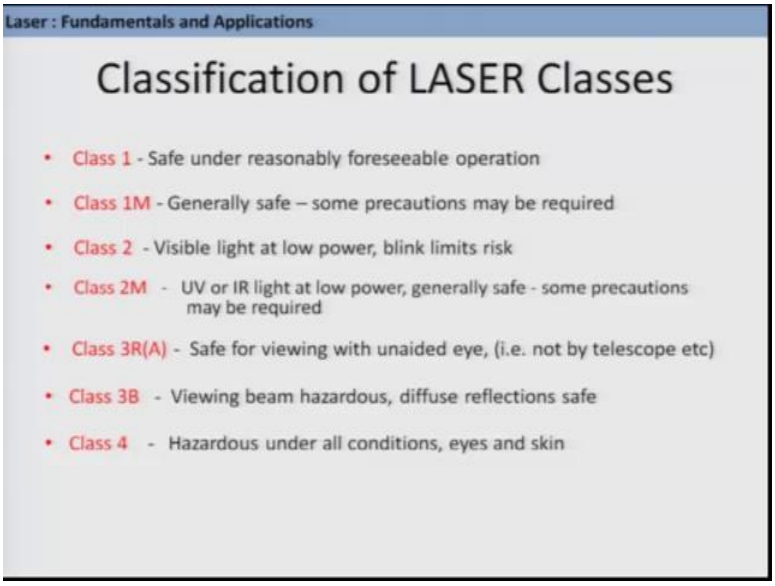

For example, class 1 to class 4. So, let us have a look at those different classes. So, the class 1 laser is normally safe thing and one does not need to care much about any possible damage with class 1 laser. Class 1M laser is also generally safe, but some precaution one should you know take about that one. Class 2 laser it deals with visible light at low power it you know and well talk about you know the danger of you know having damage from laser is essentially the you know the danger of damaging your eyes.

So, for class 2 lasers you know if you keep drinking then the risk of in eye damage is very low. For class 2M laser it uses UV or infrared light at low power it is also generally safe and some precaution you may require. Now when you comes to class 3 level laser like class 3 R or class 3 A its safe for being with unaided eye that is not by telescope or something like that then it can be very dangerous while class 3B viewing beam hazardous and if you have like you know any surface by the laser light is you know falling and you know and it can reflect to you which can be really dangerous. So, for that you make sure that whenever the laser light is falling it must have in our diffuse reflectance so that you do not you know harm your eyes.

Class 4 laser is extremely hazardous you know under all conditions it will be it you eyes be it your skin. So, one has to be extremely careful while you are handling class 4 lasers. So, here again we show in this table what are the different areas where different classes of laser are used.

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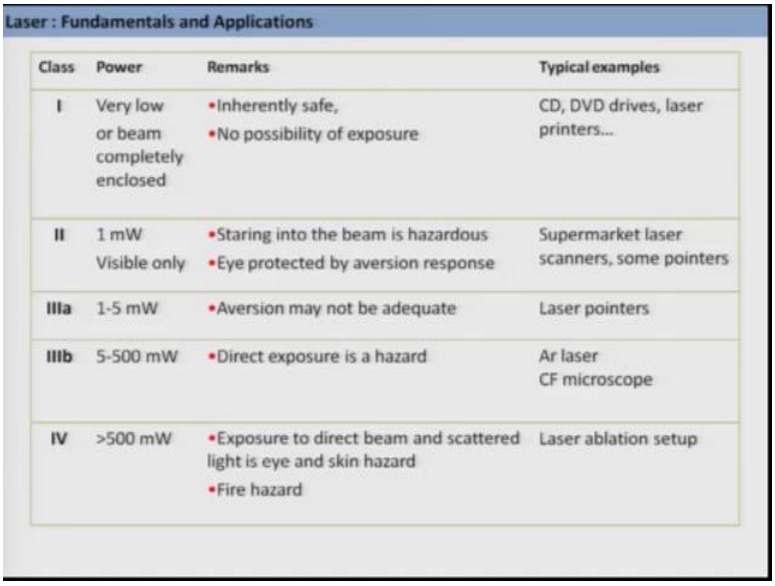

So, class 1 laser which are of low intensity their safe as you state and they are typically used in CD writer or DVD writers laser printers etcetera. While class 2 also is moderately low that is in the order of a milliwatt power and only in the visible color one should not look into this class 2 lasers for example, like you know this laser used in supermarket laser scanner and in some you know pointers that will used for seminar presentations and you should not look into this you know laser sources that can be damaging your eyes and you better used you know a suitable goggles to protect your eyes. And you know you remember whenever you use safety goggles for laser applications it depends on the laser. So, for different class of laser different color of laser your safety goggles are different. So, just having a goggles is not good enough, but knowing that which goggles do you want for the particular laser is very much needed.

Class 3 A laser is you know very often used in laser pointers and you should be careful about this laser pointers also. Class 3B lasers it is dangerous it is used in you know like many confocal microscope and basically like organ laser is a class 3 laser and you should never look at the beam even in the reflection. And class 4 laser as I said their of high power and they are you know if you expose that I means if you expose your skin or if you look at the beam its extremely dangerous you know you can lose your eyesight totally and you can damage your skin you know really in a bad way. So, like all these industrial lasers they are of you know mostly class 4 lasers like you know what we used for laser ablations and all.

Now, wherever you have your laser in any room you must you know put certain labels saying that this the room where you have this class of laser. So, you need people will know that what are the kinds of precautions that one needs to take. So, for class 2 and class 3 a laser you use this. You use the first type of label while for class 3A 3B and when we talk about class 3 A you can have either you know expanded beam or very focused beam.

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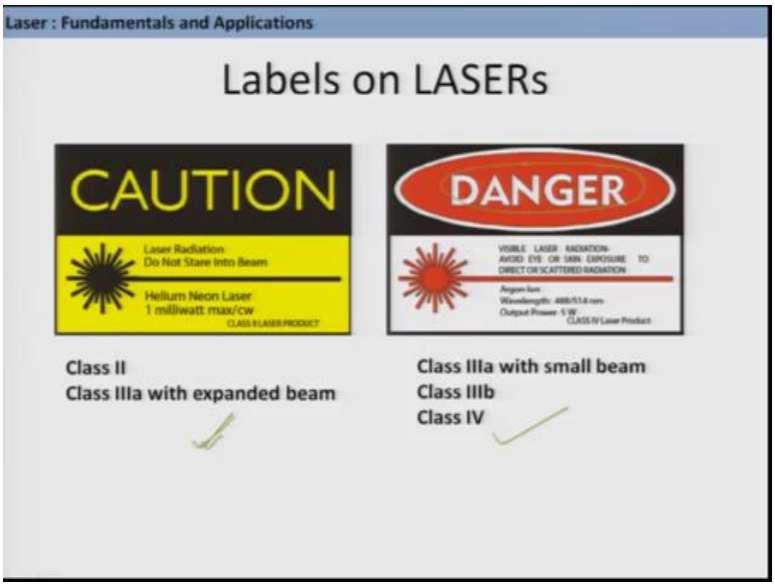

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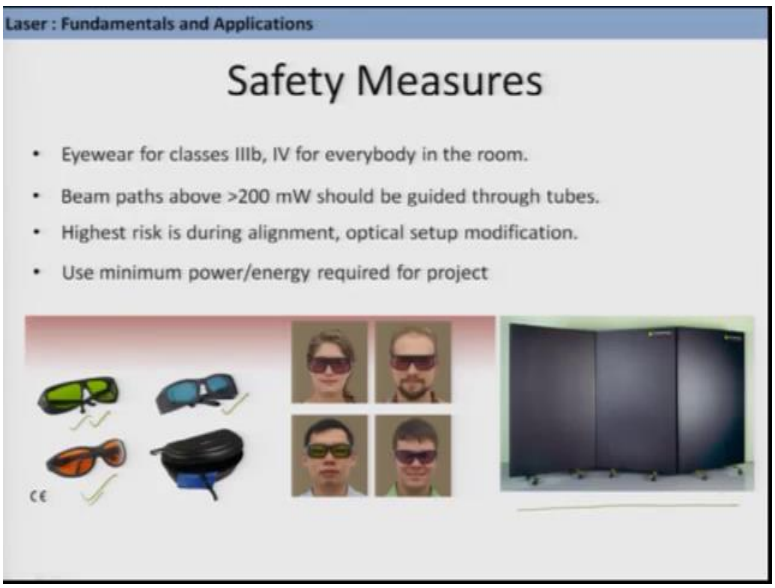

So, for expanded beam the this is sufficient, but for small beam class 3 laser or class 3 B and class 4 you need to use this sign which clearly says that this is dangerous. The other one says it is a caution. So, there is a clear difference between these 2 science one having the note caution and other having a no danger.

So, you know what are the safety measures that you need to take you know eye wear for all this class 3B class 4 lasers for everyone in the laser room and if you have beams going at you know high distance like you know and also having larger power like 200 milliwatt you must ensure that the beam goes through a tube. So, that you know even by accident no one you know gets into the beam path and get himself or herself damage. You know and the highest risk of having any accident from laser you know happens when one aligns the laser beam or you know aligns the laser light through different optics outside. So, that tells the most precaution should be you know taken more care should be taken and while doing this alignment is advisable that you use the minimum power that you can use.

And these are some examples of different type of laser you can see that there are different types of laser. So, this is for visible laser, this is for infrared laser and this lasers should kept in safe condition it should not damage the cover laser then it will not function as it is supposed to be and there are you know goggles available which you can wear even if you are wearing specs. And you know there are certain isolators are also available which you can use as a divided to in a separate out several sections of you know the room where say multiple lasers are being used which will block any kind of a laser beam falling on them.

Whenever you are using laser and once the you know the beam pass your say area of interest say for example, if you are doing spectroscopy then the sample cell was the laser passes through a sample sell after that you know you make sure that the beam is dumped otherwise the beam will go on (Refer Time: 09:21) date and someone can meet with accident. And as I you know showed you in the previous slide that you know you use some you know reflective screens which are you know kind of diffuse reflective screens to avoid any kind of accident.

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And you should not keep any unnecessary object near the laser because any moment you know if you need something from that particular part you may meet accident. Whenever you are aligning your laser beam make sure that you are not aligning it to. So, high that it comes to your eye level even now if it is only almost insatiable to do that then you make sure that laser beam there goes through tubes. And very important thing is that if you are working in laser laboratory you should know everything about laser safety and laser operation one more important thing is that whenever you are working make sure there is another person you know in a nearby place in case anything happens should be taken you know care in the second person can take care and you know not to mention no one should put your body parts with in laser beam path you are going to damage yourself in a very badly.

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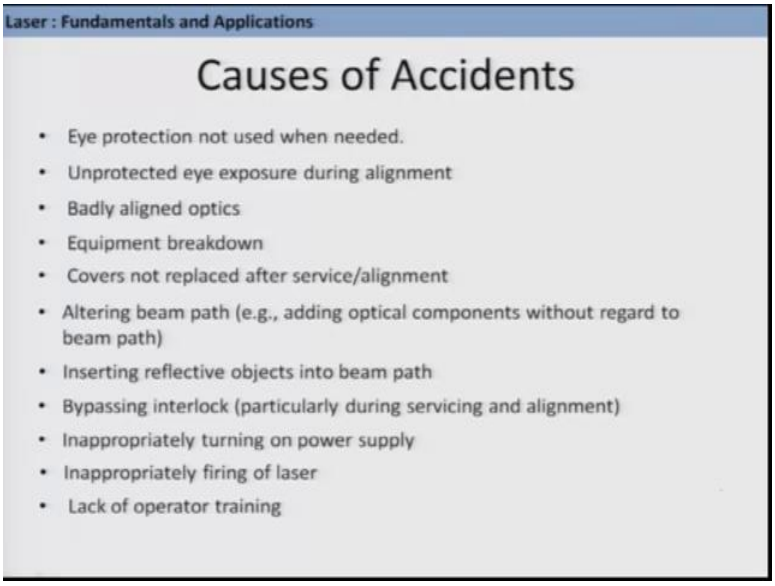

There are several causes of accident from laser sometimes people do not wear you know eye protection or you know sometime the you know optics that are on the table they are not properly align. So, the miss align beam you know takes the beam in a way direction where it is not supposed to go and someone can be accident. Sometime the equipment breaks down and then you know it means fire; the laser comes with cover. So, if the cover is not in place then you know the radiation can come out and you can have accident. Without you know informing someone else if someone incorporates and extra optics in the beam park which reflects the beam in a different direction that can cause accident.

There are certain other you know features that one should know about that is one should not put a reflective objects inside you know beam path also by passing interlock can cause serious damage. So, every laser comes with an interlock which is for safety. So, anything happens electrically, no further damage will take place interlock takes care about that one. But if you by pass the interlock then you are at risk and one should take a very proper care while turning on the power supply and you know before entering the laser lab one must have a proper training of using the laser about the laser safety without that you know you may actually meet accident.

Here are some figures where it shows you know how lasers can you know badly damage you.

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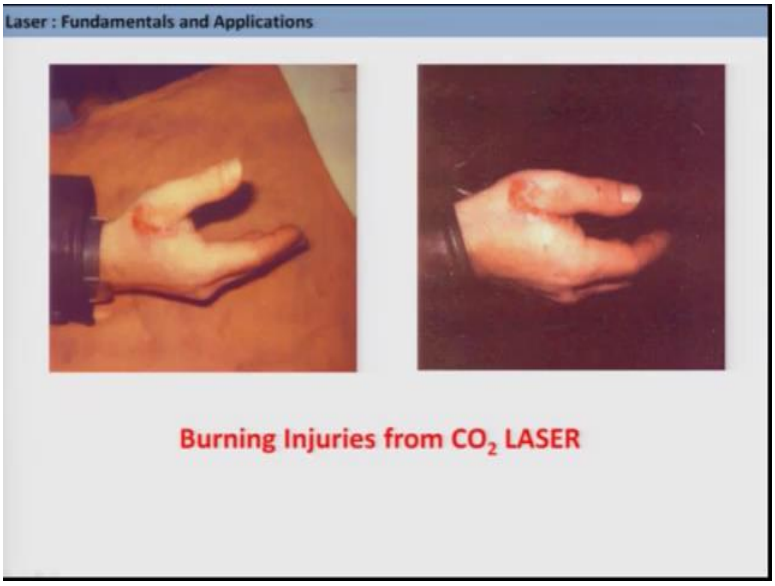

So, here the images of burning injuries from carbon dioxide laser you can see that this burning is quite severe.

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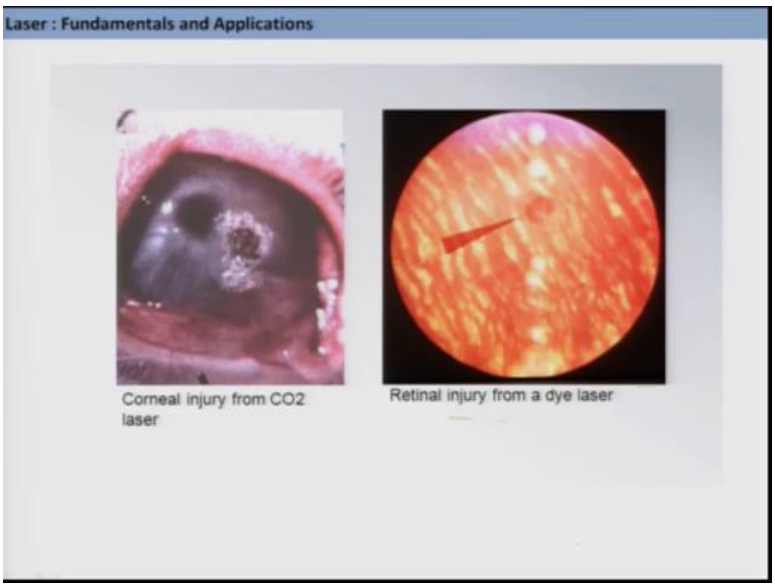

These are the corneal injuries that is in your eye from carbon dioxide laser again this on the right side it is the retinal injury from a dye laser and these injuries are quite is reversible. So, one should be very careful of.

So, with this we will pretty much conclude this course and before stopping I would like to very briefly are collect what are the things that we have looked at in the last 8 weeks.

So, we started with the importance of laser what are the places actually a laser find application in fundamental science in industry then we looked into the you know basics of or fundamentals of the laser operation. So, we talked about you know optical transitions, the requirement of population inversion and then there you know particular materials that can provide the states that can cause population inversion. So, how many states are required for having population inversion as minimum, we looked into different levels of laser system, then we looked into specific systems that can act as lasers we talked about solid state lasers, gas lasers we talked about tunable lasers like dye lasers we talked about different you know types of like continuous wave laser or pass laser within the pulse laser we talked about various different pulsing techniques like you know calorie dumping Q-switch and you know active and passive Q-switching mode locking active mode locking, passive mode locking, after learning about all those things we started looking at application side.

So, there we talked about non-linear optics we tilt with you know one particularly second order non-linear optics and second harmonic generation in specific with little bit detail and we also looked into the applications of lasers in spectroscopy and as a hole the application of laser spectroscopy in various different other fields. For example, like you know in analytical science where we showed how using ultra you know high resolution spectroscopy can help us in you know separating different isotopes we also looked into the application ultra short pulse laser in understanding the you know ultra fast chemical reactions and dynamics.

We also looked into the applications of lasers in chemistry we looked into the laser in dues chemistry we also looked into the possibilities of using lasers in understating a chemical reaction. We looked into the applications of lasers in bio metical fields we try to look into as many different fields as possible within medical sciences; we also looked into the applications of lasers in mutual science and engineering and optical communication and most importantly at the end we talked about the topic of laser safety which is very very essential.

So, I hope I could you know convince you about the need of lasers in day today life and I could also tell you about is fundamental as well as applications I hope that this knowledge though it is very basic in nature basic fundamental in nature will be very helpful for you and many of you will probably go through in much more depth after

words after having this course about lasers and laser applications. So, I wish you all the best in your future.

Thank you very much for attending this course.