Hello students, welcome to today's module, which is the part of the program Bachelor of science Second Year Subject Physics Semester three paper code PYC103 paper title waves and oscillations. Title of the unit. Is superposition of waves module name wave equation solutions module number 9. I'm Virroy Dias assistant Professor Carmel College of Art, Science and Commerce for Women Nuvem Goa. The outline of today's module is wave motion wave equation and solution.

Upon completion of this module, the student will be able to explain wave motion differentiate between longitudinal and transverse waves. Define wave equation and find its solution.

Now the first question that pops up in his students mind is why study wave motion? The simple answer to this is. That waves are everywhere. In everyday life we witness waves all around us, for example. Based on the stream. So if I tie a string. At the wall at one end and hold it on the other end. If I move it up and down I get a wave. Next Example that we see in our everyday life is a sound wave. The reason why you can hear me is because I vibrate the molecules of air which in turn vibrates your eardrums. So again, this is another form of wave motion. And both of these can be explained using classical mechanics. Another example of wave that we see is visible light. Visible light is nothing but electromagnetic waves which our eyes can detect. In our brain there are billions of neurons which transmit electrical pulses, which are again in the form of waves. If you'll study, quantum mechanics in higher studies you will learn that electron which we up till now know as a particle, also has some way properties to it. And recently all might have read about the discovery of gravitational waves. So if you see most of the phenomenon in nature have waves associated with it, and I think that's a very good reason for all of us to study motion in detail.

Now what is wave motion? Wave motion is a form of disturbance which travels through the medium due to repeated periodic motion of particles of the medium about their mean position. In wave motion, it is not a matter or the particles, but the energy and momentum that is transferred or propagated.

For example, look at this diagram below, herel. So here we have set up a system in which we are have a string of particles which is fixed at one end and the other end is attached to a piston. Now, what happens if we move the patient up and now?

As we move the piston up and down, what we notice is that the particles vibrate about their mean position. That is, the particles move just up and down, up and down about their mean position, but the energy is being transferred from one particle to the other. If you see in the diagram the diagram on the right, you can see that the energy is moving from left to right, and that's how the wave is being propagated. That is the energy is being propagated.

Now, what are the different types of waves?

Now based on the motion of the particles and of the wave we can classify waves into two types. The first type is called a transverse wave, and the next one is called the longitudinal wave. If the particles of the medium vibrate at right angles to the direction of propagation of the wave, we get what is called as the transverse wave. An example of transverse wave is electromagnetic waves. If the particle of the medium vibrate along the direction of the propagation of the wave, then we get something called as longitudinal waves. An example of a longitudinal waves is a sound wave.

Now let us derive an equation for the simple harmonic wave.
Now there are many ways by which we can derive this, but in this case we will follow. Will do it using a transverse pulse. So let us consider a transverse pulse which is traveling from left to right along the stretch string with a velocity v. So let us know if you see in this figure on the left hand side you'll see that we have a transverse pulse.
So at time t equal to 0. Let's say the pulse just start moving with a velocity V. And we can mathematically represent it by this equation. Y is equal to F of X. So let's say at a later time T the wave has moved some distance, and let's say the starting of the wave has moved a distance VT. As you can see in the left hand side corner diagram. So if the wave has moved some distance in time T, we can represent it with this mathematical equation. That is Y is equal to F of X minus VT, and this situation represents a pulse advancing from left to right.
Now, It can be shown at the function F of X is a function of sine or a cosine. So using this we can write the general equation of a wave propagating from left to right at time T. As follows, where Y is equal to A sine two pi by Lambda X minus VT.Where A is nothing but the amplitude of the wave and Lambda the wavelength of the wave. For a wave which is moving from right to left, this general solution is given by this equation. Now, if you notice here that for a wave propagating from left to right. We use a negative sign in the bracket and for a wave is propagating from right to left we use a positive sign to denote it.
The general equation of simple harmonic wave that we have just derived is as follows, which is this. If we differentiate the above equation two times. Let us say we differentiate twice with respect to time. You get this equation. So let's call this equation number 1. And we differentiate this equation of simple harmonic wave two times, again with respect to X. Then we end up with this equation. Let's call this a question number 2. Now if it divide this equation one and two and rearrange it, we get thi, equation. And this is nothing but the equation of the wave. So this gives us the equation of motion of the wave. So what this means is if we, substitute this equation of, the general equation of simple harmonic wave in this equation it should satisfy this equation.
These are the references that I've used for my module. With this we come to the end of this module. Thank you.